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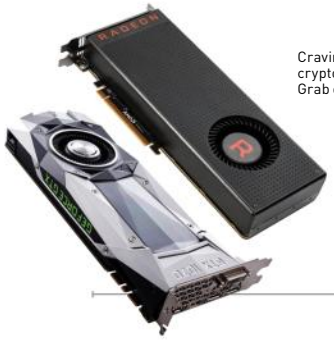


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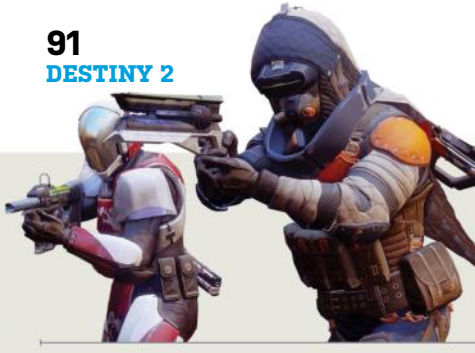

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# Tuan Nguyen

# I'M READY FOR AN INTEL-BASED GRAPHICS CARD

**FROM TIME TO TIME,** I reminisce about the old days of tech—the early 2000s, to be precise. I guess that wasn't too long ago, but it feels like eons. So many things have changed. Actually, I probably think about those days because I'm hoping for some of what happened to reoccur. I'm talking about when there were lots of companies competing for each component in your PC. I thought those days were gone, leaving just a handful of large businesses competing, but some of what I've been hoping for is about to re-emerge.

At the tail end of 2017, after a year of 15 to 20 percent improvements in primary hardware components, and an ocean of RGB devices, Intel shocked the tech world with an announcement no one expected: It would be forming a partnership with long-time rival AMD, to bring a combined processor to the market. The CPU would have an Intel CPU core and an AMD Vega GPU core in a single package.

This is big. Huge. The announcement followed the surprising news that AMD's Radeon boss, Raja Koduri, had resigned from AMD to join Intel. While the world held its breath, Intel was already fabricating its new mobile chip that incorporated AMD's Vega graphics technology. Just several weeks after the announcement, I had the chance to play with a new Dell XPS that incorporated the new chip. Although I wasn't allowed to run benchmarks, the new XPS is going to have graphics performance previously unseen in its class, coupled with battery life that rivals even Apple's legendary MacBooks. This is progress.

What I'm most excited about, though, is the possibility of Intel becoming a real third major competitor to jump into the fight with AMD and Nvidia. If you've been around long enough, you'll remember that Intel once had its own graphics chip, called the i740. During a time when motherboards only had ISA and PCI slots, Intel used the i740 to move the industry on to the AGP bus, which was dedicated solely to high-performance graphics. Once the industry embraced AGP, however, Intel exited the discrete graphics chip market entirely.

While it's hard to say for sure that Koduri will bring Intel back into the discrete game, where you'll be plugging an Intel-based graphics card into a gaming PC, there is hope. What I think will likely happen first, though, is that Intel will focus on higher performance mobile parts—both laptop and cell phone chips. It's a good entry point for Intel, because its for-laptop CPUs still dominate the industry, but its integrated graphics solutions lag behind offerings from both AMD and Nvidia.

In the original press release, Intel specifically said that Koduri would focus on both integrated and "high-end discrete" graphics. So, maybe my sentimental feelings for the earlier years are coming back. C'mon, Raja, make my dreams come true. Again.

*Tuan Nguyen is* Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 20 years.*

↘ submit your questions to: comments@maximumpc.com

# THE NEWS

# Bitcoin, Ripple, and CryptoKitties

## All aboard the blockchain train, destination unknown

**BITCOIN DID RATHER WELL** last year, to put it mildly. Talk and speculation is now everywhere. Bubbling under, however, we have a new hot property: Ripple. This rose 120 percent in a week, to become the second largest cryptocurrency by market value. One to watch, and there's good reason: It can do what Bitcoin struggles to achieve.

Bitcoin remains the trailblazer for now. It started last year trading at $976 a pop, high enough to start attracting attention from pundits, investors, and less savory characters. Stories of Mafia money laundering and North Korean sanction dodging painted a somewhat unwholesome image, and major financial figures, such as Warren Buffett, were scathing. However, the new generation of tech money was hot.

More cryptocurrencies were launched, and Bitcoin was seen as the benchmark for an emerging market of blockchain-powered currencies. People started to jump aboard, and the bandwagon gathered pace. By August, it had reached $2,787, and started to enter more mainstream business. It became legal tender in Japan, and banks started dabbling. In November alone, it jumped by nearly 40 percent. The price finally spiked on 18 December at $19,498, before settling down to $13,378 at the end of the year. Some people were clearly making a lot of money, and it had everybody's attention.

So, where now? Despite unflattering comparisons with the Dutch tulip mania of the 17th century, the bubble, if it is indeed one, refuses to burst. There is a problem, though: The blockchain is getting big, and it's getting slow. Banks can alleviate this by bundling together transactions, but this requires some solid trust, and a stable price. Bitcoin's blockchain wasn't designed for this kind of load.

As digital gold, it has problems, too. The blockchain consumes enough electricity to run a small European country, which is ludicrous. This has led to a worrying concentration in the land of cheap electricity: China. Bitcoin has faced sanctions there, and if the State Council were to pull the plug, it would cause a sizeable wobble. As the Bitcoin blockchain gets closer to its mathematical end, mined coins become rare; somebody will have to pay that electricity bill. One good thing about actual gold is you don't need to plug it in to ensure its existence; it'll stay exactly as it is until the sun turns into a red giant.

The real story is the blockchain. Of the myriad recent cryptocurrency launches, most of which are withering on the vine, we still have Ripple. This was designed from the start to be about quick and seamless transactions. It has been picked up by a slew of big credit card companies, including American Express.

Unlike Bitcoin, all the coins have already been mined, and are simply released as it grows. The blockchain is run by those people who want to use it. Ripple's recent spike is not welcomed by all. This bandwagon does not want to roll too fast, because its use in banking requires a certain stability. At the same time, miners and speculators looking for new veins to plunder have moved to Stellar, Ethereum, and Litecoin. Oh, and CryptoKitties—yes, digital kittens.

The blockchain is here to stay. The increasing complexity of these chains as they mature means they will have to be periodically reset. Digital money is here to stay, too. Bitcoin will always be known as the first over the wall, and will survive at some level for the foreseeable future. The lasting legacy, however, will be the introduction of the blockchain itself, and that will be anywhere that a complex list of data needs to be managed across multiple systems, which in the age of the IoT, is all over the place. Meanwhile, we will undoubtedly have more highs and lows in various flavors of cryptocurrencies, that will continue to annoy us by making certain GPUs more expensive than they should be. **–CL**

> One good thing about gold is you don't need to plug it in to ensure its existence.

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# APPLE'S BATTERY BROUHAHA

## It was for your own good!

**OLD IPHONES** can get slow, and the suspicion was always that Apple was deliberately throttling them to push upgrades. The iPhone 6 seemed particularly prone to this. Tempers shortened, forums filled with complaints, and rumors passed back and forth. At least four class action lawsuits were filed. Third-party testing revealed that the slowdown was real: Old iPhone's are having their processors slowed down by the OS. Apple finally admitted what it was up to.

Apple issued a statement just before the New Year confirming that a software upgrade last year (iOS 10.2.1) does indeed detect a battery with degraded performance, and slow things down if power demand is too high. It did have reasonable technical arguments for this: Old batteries can't reliably supply the peak power of a fresh one; if it drops too far below requirements, your phone simply shuts down, which you don't want. That's why iPhone 6 users would see their phone go black at 30–40 percent charge for no apparent reason. It wasn't being mean, just practical.

In response, Apple has cut the cost of a new battery kit for out-of-warranty iPhones from $79 to $29—a welcome move. This will have your phone running at tip-top speed again. Though you have to wonder why it charged $79 in the first place.... It also promises to add tools that enable you to get a better picture of your battery's condition. So, it's not a diabolical conspiracy to get you to upgrade, just an inept company that won't admit what it's doing until threatened with lawsuits, and a lot of unhappy customers.

One reason this has surfaced is the slowing rate of upgrades—people are hanging on to iPhones for longer than they used to; witness the sluggish sales of the iPhone X. The iPhone 6 has the basic functions you need, and a headphone jack to boot. A surprising number of people are still rocking one, it seems. **–CL**

# GAMING DISORDER OFFICIAL

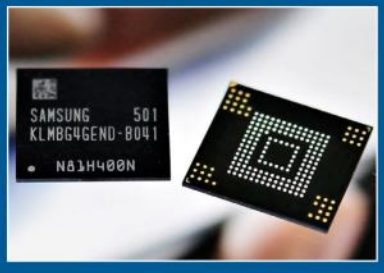
## YOU ARE SICK, DUDE

**THE WORLD HEALTH ORGANIZATION** has classified an addiction to gaming as a metal health disorder, and has issued a guide that outlines the symptoms and diagnosis of the condition. Many countries already recognize gaming addiction as a identifiable and treatable condition. South Korea has a law that bans those under 16 from playing online games between midnight and six in the morning. China also limits the hours for younger players.

Not everybody is happy about this. Critics argue that extensive gaming is simply a coping mechanism for other metal health issues, rather than a specific one in itself. They point out that any "fun" activity can be taken to extremes, and cause suffering. To be clear, this isn't about enthusiastic players, or the odd night lost to a marathon session. Gaming as an intense hobby is a long way from addiction. Sadly, it's young children who often suffer serious neglect when parents become more interested in gaming sessions than them. **–CL**

# MEMORY PRICES MAY BE FIXED

## Authorities looking into Samsung. Again




**WHEN PRODUCTION** struggles to satisfy demand, prices go up. That's basic economics. However, last year's increases in DRAM and NAND prices have raised suspicions. The Chinese anti-trust regulator is looking into the possibility of collusion between the big manufacturers to limit supply and maximize profits. Senior official, Xu Xinyu, is quoted as saying they had "noticed the price surge, and will pay more attention to future problems that may be caused by price fixing."

This follows complaints from the big Chinese phone makers about a series of significant price rises over the last year (typically 50 percent). This made memory the single most expensive component in a phone, above the CPU and screen. If evidence is found, a large fine will be dished out. Samsung has been caught out like this before—in 2005, it was fined $300 million for fixing prices. Perhaps we'll get cheaper memory out of this, who knows? With so few big players in the market, price fixing of such a vital commodity is worrying. **–CL**

# Tech Triumphs and Tragedies

**A monthly snapshot of what's good and bad in tech**

## TRIUMPHS

**PUBG A HUGE HIT**
Despite having no franchise or brand to push it, *PUBG* is now bigger than the next nine games on Steam put together.

**APPLE LISA GOES OS**
Apple has given the source code of Lisa, the precursor of the Mac, to the Computer History Museum.

**HARD DRIVE BOOST**
Seagate has developed an HDD with multiple actuators, initially two, which will double speeds. Four arms are being planned.

## TRAGEDIES

**FBI USES RUSSIAN CODE**
The FBI and 18,000 other agencies use fingerprint analysis software containing code from a firm with strong ties to the KGB.

**FACE RECOGNITION FOOLED**
An infrared photo can fool Win 10 Hello face recognition security; latest builds are largely immune.

**STARBUCKS MINING**
Argentinean branches' Wi-Fi was caught installing Monero Miner to mine Bitcoin on customers' machines—local ISP blamed.

Jarred Walton

TECH TALK

# Nvidia's Titan V Brings Volta to Consumers

**LAST MONTH I TALKED ABOUT** Intel's increased efforts in the field of AI, and this month Nvidia launched a new consumer product that targets the same market. Nvidia already has a professional solution, with its DGX-1 servers and Tesla V100 processors, but the latest addition is something of a surprise.

The Titan V is a prosumer product, designed to take deep learning and AI research mainstream. It seems silly to call a $2,999 graphics card "mainstream," but the Tesla V100, which has similar specs, is currently only available in packs of eight, shipped inside Nvidia's DGX-1 servers, which cost $149,000. About $29,000 of that can be attributed to the core server components, with the remaining $120K going to the eight Tesla V100 cards, which means one V100 costs around $15,000—the Titan V is a bargain by comparison! The DGX-1 also uses NVLink mezzanine connectors for higher bandwidth interlinks, while the Titan V sticks with the PCIe x16 interface, so you can drop the card into just about any modern PC, and suddenly have a deep learning powerhouse.

How powerful is the Titan V? Nvidia rates it at up to 15 Tflops for single-precision operations, 7.5 Tflops for double-precision, and 30 Tflops of FP16 operations. But the kicker is the new Tensor cores, customized for high performance deep learning operations that don't need higher precision. There are 640 Tensor cores in the Titan V, providing 110 Tflops in total of FP16 performance—roughly five times faster than the previous-gen Pascal, and nearly 10 times faster than any previous GeForce.

Nvidia has also overhauled some of the underlying architecture in Volta. There are rumblings that the changes make it better for low-level APIs, such as DX12 and Vulkan, with asynchronous compute being one area of traditional weakness on Nvidia's recent GPUs, but we haven't been briefed on any specific changes yet. The GV100 processor is very much focused on areas other than gaming, and it has more similarities to the GP100 architecture—a chip that never actually showed up in any consumer products, unless you count the Quadro GP100, which retails for $8,500.

The full GV100 includes up to 84 SMs (Streaming Multiprocessors), with half as many CUDA cores per SM compared to the Maxwell GPUs like GM104, plus eight Tensor cores. It has a base clock of 1,200MHz, and a boost clock of 1,455MHz. The Titan V also includes 12GB of HBM2 memory, down from the 16GB that the GV100 supports, so it is partially disabled—four SMs and one HBM2 stack are disabled. That's hardly surprising, as the chip is massive, measuring 815mm$^2$, with 21 billion transistors, and manufactured on TSMC's 12nm process; it's as big as Nvidia could make it with current tech. Large chips mean lower yields, but by designing in redundancies, and allowing portions of a chip to be disabled, Nvidia can get more chips from each wafer.

While the Titan V is not intended for gamers (it doesn't even have an SLI connector), that doesn't mean it can't run games. With around 20 percent more compute performance and memory bandwidth than the Titan Xp, if you're serious about AI research and want to play games after hours, the card is no slouch. It's early, so the drivers aren't fully optimized, but in testing there are games where the Titan V is up to 25 percent faster than a GTX 1080 Ti—and others where it's slightly slower, but it's a net overall gain.

**The Titan V packs more CUDA shaders than any previous GPU.**

The GTX 1080 Ti is far more sensible for gaming purposes, and Nvidia is serious about this being an "entry level" AI chip. With 10 times the deep learning performance, it puts more power than ever into the hands of software developers. I can't wait to see what they do with it.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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Alex Campbell

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# Open-Source Encrypted Messaging Making Strides

**CHANCES ARE GOOD** that you're using crypto in your communications now. In fact, a lot of communication tools use some sort of encryption by default. That said, it never hurts to take stock of what you (and your contacts) are using and trusting every day.

Love him or hate him, Edward Snowden's leaks spurred on the rapid adoption of private messaging and encryption platforms. And crypto isn't just for spies, either. Whether it's coming out to a trusted friend or engaging in activism, keeping communication safe involves trust. First, you have to trust the recipient of your message. But you also have to trust the medium.

Even without end-to-end encryption, most communications using major web applications are encrypted in transit with TLS. (If the URL you're visiting starts with "https://" you're using TLS.) But even with TLS, the service you're using (such as Twitter or Facebook direct messages) is wide open to anyone who has access to your account or has a subpoena in hand. Luckily, a lot of people are using end-to-end encryption by default.

Facebook's WhatsApp is the most popular messenger in the United States, and as long as someone is communicating over data, their conversation is protected. While WhatsApp is proprietary, its crypto is sound. In fact, it uses the same protocol as Signal, the open-source secure messenger.

**Keybase and Signal desktop apps for Windows 10.**

While I have to stress that WhatsApp is still pretty darn secure, I like knowing that an application is both secure and open-source. While there are other options available, the big juggernauts in the room are PGP, Keybase, and Signal.

What has caught my eye lately is how far Keybase has come. Keybase started as an alternative to traditional PGP keyservers, offering ways to authenticate a PGP public key through a user's Facebook, Twitter, and GitHub accounts. In 2017, Keybase added support for messaging, secure file sharing, and Slack-like chat functions.

Signal has made great progress as well. Group chats, audio calls, and video calls all work quite well. On top of that, there is finally a standalone desktop client for Linux that doesn't require you to run it as a Chrome app. That's no small thing, either: It means that you can type out longer messages that might be tedious to do with your thumbs. The desktop app also allows you to attach documents and other files, which can be useful if you want to share something besides a photo. It also means that newly converted Firefox Quantum users don't have to hang on to Chromium just to get Signal on their desktop.

And fret not, Windows users: Both Signal and Slack are now available as desktop apps on Windows as well.

Finally, there's good old PGP itself. While PGP is used to encrypt email, you can also use it to sign and encrypt files. With PGP, you can encrypt files and share them with an intended recipient over any untrusted medium.

While PGP is good from a technology standpoint, it still sucks in terms of user experience. PGP can be hellish for newbies to set up correctly, especially for those unfamiliar with the console. On top of that, key security (keeping the actual private key file secure) is a pain. In the years I've had PGP enabled in my email clients, I've never received or sent a PGP-encrypted email. So, unless you have a bunch of friends who already have PGP keys, you probably don't need to think too much about it.

Both Signal and Keybase are great tools, and way easier to use than barebones PGP, but they enjoy a much smaller userbase than WhatsApp. So which should you use? Whatever you can convince your contacts to use, of course. After all, it takes two to tango. All of the encrypted communication software in the world does you no good if nobody else is using it.

Alex Campbell is a Linux geek who enjoys learning about computer security.

# THE LIST

## TOP 8 GRAPHICS CARDS FOR MINING

### 8 NVIDIA GEFORCE GTX 1060 3GB $180

A great mid-range gaming card that can also turn its hand to mining. Top value all around.

### 4 NVIDIA GEFORCE GTX 980 TI $250

Mining isn't all about the latest hardware; high-end last-gen cards can still do the work.

### 7 AMD RADEON R9 390 $205

If you find one at the right price, the R9 390 is a good mining card for the money.

### 3 AMD RADEON RX VEGA 56 $420

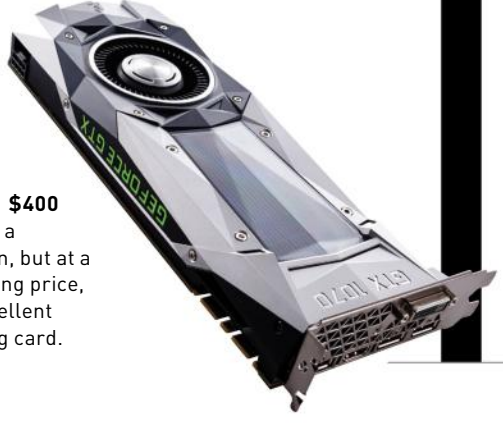
Like its bigger brother, this is great for mining, and a slightly better proposition, value-wise, for gaming.

### 6 AMD RADEON RX 580 8GB $295

Mining has destroyed the value proposition of this card, but if you can get it cheap, it's superb.

### 2 NVIDIA GEFORCE GTX 1080 TI $710

Buy it for gaming, use it for mining. You won't lose out if cryptocurrencies fall off a cliff.




### 5 NVIDIA GEFORCE GTX 1070 $400

Equivalent to a Maxwell Titan, but at a more appealing price, this is an excellent 1440p gaming card.

### 1 AMD RX VEGA 64 $500

It may not be amazing for gaming, but Vega excels at mining cryptocurrencies.

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HEAD TO

BY ZAK STOREY

# Stock Cooling vs. Air Towers vs. All-In-Ones

For most people, cooling is an unwanted expense. And, arguably, they're right. If all you're doing is building a rig for office work and browsing the web, the included case fans and stock CPU heatsink are usually sufficient. But when you're using heavier-hitting hardware and putting more demands on your machine, something a little meatier is called for. So, it's time to work out which of the three main types of CPU cooler wins the title of world's best.

## ROUND 1

### Cost

When it comes to specing up a new rig, the cost of cooling is a major issue, and it can also be a big part of the overall cost of a processor. Take AMD, for example—all its X edition processors lack a stock cooler as standard. The same goes for Intel's K series. This means that even if you're not that keen to overclock and push your chip to the max, but are just after the chip's full-fat performance and higher frequencies, you have no choice but to buy some form of aftermarket cooler. As a whole, so far as value for money goes, both AMD and Intel's stock heatsinks are clearly king of the hill. Adding little extra to the overall price of the processor, these TDP-busting parts are often included with lower-specced CPUs for free. Air towers fall into second place in this battle for bang-for-buck supremacy, with prices ranging all the way from $8 up to $90, in some cases, with the top end touting impressive TDP-reducing properties. And lastly, of course, there are AIO liquid coolers. Although you can find a few at fairly reasonable prices, they generally range anywhere from $50 all the way up to $160 or more, due to their complex designs and additional components.

**Winner**
**Stock**

## ROUND 2

### Ease of Installation

Most methods have installation issues. Intel's stock cooler can cause trouble if you're not used to the design of its push pin mounting mechanism, and AMD's latch mounting can lead to a lot of cut fingers and frustration, too. We're going to give a special mention here to AMD's stock Wraith Spire, though, as it's one of the best mounting designs we've seen on a stock fan, relying on four diagonal screws to be secured, and that's it. Air towers vary when it comes to ease of installation, with some manufacturers being less than helpful—usually, the more you pay, the easier it is to install, Noctua models, in particular, are exceptionally painless. Taking the tower clearance of your chassis into account is pivotal, because some air towers can be too big for your system. Ultimately, however, as long as you have the radiator mounting space (and, let's face it, almost every chassis has support for a single 120mm), AIOs win the day. Moving the surface area for cooling to the sides of the chassis, and away from the center, allows better compatibility with memory. On top of that, most AIOs follow Asetek's patent, meaning an identical mounting solution.

**Winner**
**All-In-One**

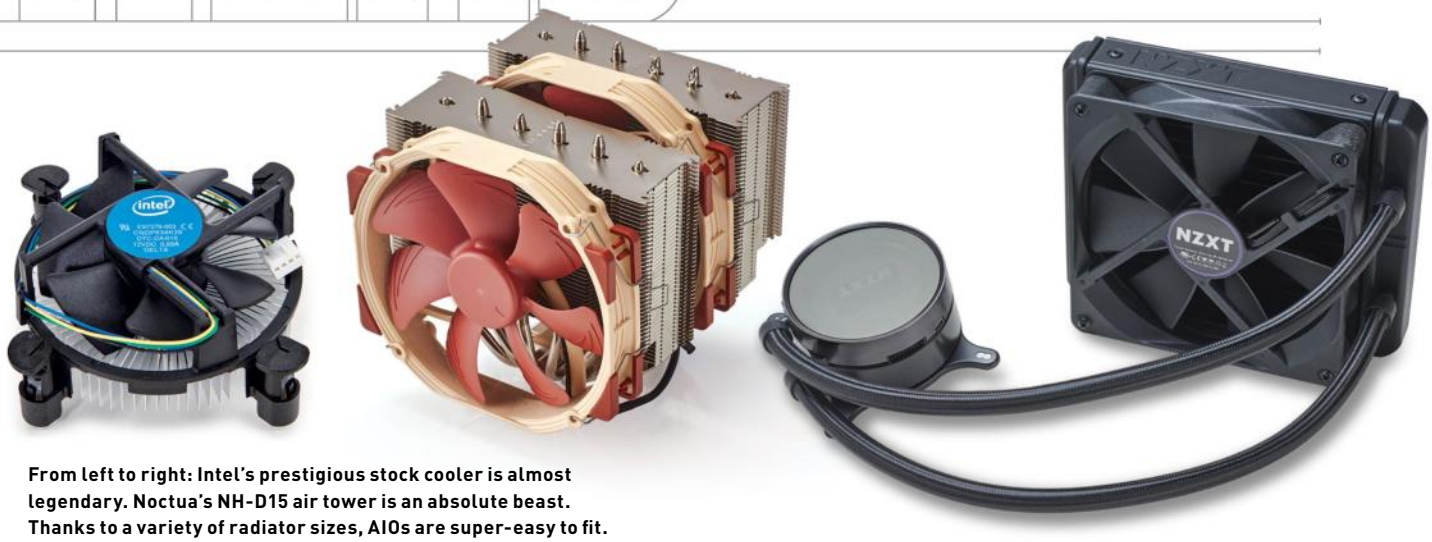
## ROUND 3

### Cooling Efficiency

All cooling follows the same basic principle: Via the use of convection and vapor for air towers, and a pump and liquid for AIOs, heat is transferred away from the CPU and toward the fins, where it is then cooled by cold air passing across it, before it returns back down to the CPU to start the process again. Regardless of whether that's a stock heatsink, air tower, AIO, or even a full loop, each method follows the same idea. So, when it comes to efficiency, there's one simple rule to follow: The more surface area you can cool, the better your cooling is going to be. Right now, AIOs rule the roost. With the largest radiators topping out at 360mm in length, and supporting up to six 120mm fans, these are designed for the biggest processors and the beefiest of overclocks. Air towers come a close second, with the likes of Noctua's NH-D15 supporting up to two 140mm fans over two towers. And, lastly, the stock cooler, with its tiny individual sub-120mm fans, falls into third place. Although capable in some cases of supporting overclocks, these coolers are typically only there for—as the name suggests—running at stock.

**Winner**
**All-In-One**

# HEAD




**From left to right: Intel's prestigious stock cooler is almost legendary. Noctua's NH-D15 air tower is an absolute beast. Thanks to a variety of radiator sizes, AIOs are super-easy to fit.**

## ROUND 4

### Noise

Despite what many think, more fans doesn't necessarily mean more noise. The theory here is simple: As you inevitably always have the same maximum temperature to alleviate, you always need to hit that as a bare minimum. One fan cooling a processor, for example, would need to be spun at a far higher RPM (generating much more noise) to provide similarly efficient cooling as two fans of the same size over the same surface area. Because of this, and due to the way that decibels scale logarithmically, two 24dB fans (where 25dB is a doubling in noise), operating in tandem, are far quieter than a single 32dB fan. In a similar fashion as cooling efficiency, stock coolers are generally not the best fit for this. Although they can be quiet, due to the type of chip they're likely cooling, the smaller sized fan and lack of surface area mean higher RPMs. We could hand this to AIOs, due to their increased surface area over air towers, but there's one hiccup: the poor quality of the stock fans included. Most air towers are designed with lower RPM, quieter fans in mind, because the cost comes from those rather than the pump and radiator.

**Winner**
**Air Tower**

## ROUND 5

### Reliability

As systems become ever more integrated into our daily lives and our work, from cryptomining to rendering rigs, office workstations, and even the gaming rig used for relaxing in the evening, reliability is paramount. Both AIO coolers and air towers generally come with fantastic warranties, but there's one big problem when it comes to liquid coolers: If it breaks or, even worse, leaks, it can take your entire system with it. Liquid and PC hardware simply don't mix. On top of that, if your pump stops working in a water block, that CPU is going to cook very quickly indeed, and shut off your system even at idle. Air towers, on the other hand, don't have this moving pump part, and can still operate, thanks to the power of convection, even if a fan breaks. In addition, if your pump dies in an AIO, you have no choice but to replace the entire unit; if a fan dies on an air tower, you simply replace the fan—at a far lower cost. Stock coolers face a similar problem as liquid coolers: If the fan dies, due to the lack of significant surface area, that processor is going to get hot quickly, and you'll have no choice but to replace it.

**Winner**
**Air Tower**

## And the Winner Is...

There never will be a one-solution-fits-all when it comes to CPU heatsinks. Regardless of how you look at it, whether it's one of our three categories or something else, each type of cooling has its flaws. Ultimately, it often depends entirely on what processor you're cooling—after all, there's not much point putting a 360mm triple-fan AIO on top of an Intel Core i3-8100. For many, the stock cooler will work just fine. However, for us, arguably it's all about choosing the right aftermarket solution AIO or tower. Although liquid coolers are by far the most efficient at transferring heat quickly, and a fantastic option for those looking for a stylish and compatible cooling solution for the hearts of their machines, there is some inherent risk. If it were a life and death situation, and someone forced us to pick just one, an air tower would be our answer. They simply are king of the hill. OK, so there are a few clearance issues every now and again, but thanks to their simple design, exceptional performance, and consistent reliability, there's little not to love about them.

# DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Hard Disk Dilemma
> Office Work
> Privacy Issues

## Disk Problem?

Hi Doc, I'm wondering if I have a failing hard drive or a bigger problem. Two months ago, I replaced my old Dell XPS 420 (running Windows 7) with a new Dell XPS 8910 (bundled with Windows 10). I moved my data drive, a three-year-old WD Black 1TB that I use for storing videos, from the old computer to the new one.

Possibly coinciding with the Windows 10 Fall Creators Update, my video recordings now abort intermittently. I see an Event ID 129, iaStorA, "Reset to device, \Device\RaidPort0, was issued" entry in the log each time.

Although I haven't been able to find information about this log entry, it looks like a disk problem to me. I ran WD's Data Lifeguard Diagnostic on the drive, and it passed the quick and extended tests. I temporarily changed my video storage location to the system drive, a Toshiba 1TB HDD, and there have been no failures while recording to that disk.

Do I have a failing data drive, or do I need to look for more serious problems with my PC? **–Tom Wolff**

**Eighth-gen Core CPUs offer more cores and cache, but are still very expensive.**

**THE DOCTOR RESPONDS:** Before the Doc gives an oddly specific suggestion for resolving this error, he wants to make sure you've exhausted the "easy fixes." The new system's BIOS is up to date? Intel's Rapid Storage Technology driver is current? Your video software is patched? All right, good.

If all else fails, the problem might be related to power management on your storage interface. Getting under the proverbial hood to tweak its settings does require working in the Registry Editor. Standard disclaimers apply, then. Only mess with the Registry if you understand and accept the potential for catastrophic loss.

Navigate to "HKLM\SYSTEM\CurrentControlSet\Control\Power\PowerSettings\0012ee47-9041-4b5d-9b77-535fba8b1442\0b2d69d7-a2a1-449c-9680-f91c70521c60" and change the "Attributes" DWORD from 1 to 2. Now open up the Control Panel and click the Power Options icon. Next to the power plan you're using, choose "Change plan settings," then select "Change advanced power settings." After expanding the "Hard disk" tree, a previously hidden option, "AHCI Link Power Management—HIPM/DIPM" should now be visible. Change its setting to "Active." According to Microsoft, this disables link power management.

While you're at it, try expanding the "PCI Express" tree and changing "Link State Power Management" to "Off."

## More Office Woes

Hi Doc. Welcome to my corner of install hell. When I installed Windows 7 and Office 2010 on my work computer, I had the same symptom as Ken in your December 2017 issue. Except it happened to me every time I double-clicked an Office document. The Microsoft Single Image install, whatever that is, always wanted to run before opening my files.

After months of frustration, I finally called Microsoft tech support. They logged into my PC and spent over four hours un-installing, reinstalling, and re-reinstalling. All of it was unsuccessful. Their final diagnosis? I had to perform a clean install of Windows in order to fix their product!

I must have at least 100 other programs on my PC, and not one of them has similar problems. At the time, I asked Microsoft's reps if they really expected me to re-install every other piece of software to fix Office, and guess what? I still have to click "Cancel this install" every time I open an Office document.

Maybe your reader should try OpenOffice instead....

**–Pres Tuesley**

**THE DOCTOR RESPONDS:** Hear that, Ken? If the Doc's idea to eradicate all evidence of Office from your machine before trying to reinstall it didn't work, you could be facing a challenge that even Microsoft's own support staff cannot resolve.

The Apache Software Foundation recently released OpenOffice 4.1.4 with miscellaneous bug fixes, security fixes, and updated dictionaries. It's available for Windows, OS X, and Linux. Best of all, it's free. That might be the way to go, rather than fight Office's idiosyncrasies.

## The Mini-ITX Build

I want to build a secondary system for tasks such as

↘ submit your questions to: doctor@maximumpc.com

Blue Iris (camera recording), UniFi (network management), HomeSeer (smart home system), and a few others. Currently, I have these on other machines spread around the house. It's time to consolidate them with a machine I can stick in a closet.

Naturally, I'd like to use a small form factor like Mini-ITX or microATX. What motherboard and CPU combo would yield good performance at a reasonable price? A high thread count is preferable. I have everything I need except the processor, motherboard, and DDR4 memory. I'd like to stay under $300 for the CPU/motherboard. Is AMD or Intel the better option for this kind of build? **–Duane Crider**

**THE DOCTOR RESPONDS:** AMD's newest Ryzen CPUs generally serve up more cores/threads at a lower price. However, Intel's cores still get more work done per clock cycle. Eighth-gen Core CPUs, based on Coffee Lake, are particularly potent for their higher core counts and cache capacity. Plus, that Blue Iris software takes advantage of Intel QuickSync technology for hardware-accelerated video decoding.

But Core CPUs tend to be more expensive. At the time of writing, an i3-8350K sells for $190 and doesn't include a thermal solution. No way you'd be able to duck in under $300 for a complete platform using Intel's latest and greatest.

Faced with a choice between an older dual-core Intel chip and a quad-core Ryzen, the Doc would point you in AMD's direction, particularly if you'll have all those apps running on one machine. A four-core/eight-thread Ryzen 5 1400 costs about $150, and Mini-ITX mobos start in the $115 range (ASRock Fatal1ty AB350 Gaming-ITX/ac and Gigabyte AB350N-Gaming WiFi). That even leaves a few bucks for DDR4 memory.

## Network Privacy

Doc, how hard is it to see someone's IP address, or cell phone number, on a wireless networking hub? These hubs hook up to a Cisco switch, which connects to the web through a dish at 200Mb/s.

Where I work, our company installed three wireless networking hubs with a guest account we all can use while we're there. Recently, the question came up whether our IT department can see when we're accessing the Internet through our cell phones. How private is the access we've been given? **–Larry**

**THE DOCTOR RESPONDS:** Assume it's not private at all. If your phone is company-issued, the IT department has access to it and can see any of what you wouldn't want it to. Even in a bring-your-own-device environment, unencrypted network traffic can be monitored. If you're careful, and use encrypted protocols, the domains you visit are still visible. Naturally, that could become a problem.

Your safest bet is to use and respect the company's IT as though it were monitored at all times.

## Time for a Video Card?

Hi Doc, I just built a computer. It's a general-purpose PC for my home, and for working with my digital camera system (seven cameras). I do not use it for gaming.

The system includes an Asus ROG Maximus IX Hero, an Intel Core i7-7700 (Kaby Lake), and a 1TB Samsung 960 Pro M.2 NVMe drive. To store video, I added two WD Red Pro disks. The monitor is a 34-inch Asus ProArt PA329Q, natively running at 3840x2160.

As of right now, I'm not using a discrete graphics card. The signal from my Core i7's HD Graphics looks good enough to me. If I did buy a new board from AMD or Nvidia, though, would on-screen quality improve? Also, I'm using a DisplayPort cable. Is this any better than HDMI? **–Mr. Lynn Wyatt**

**THE DOCTOR RESPONDS:** According to Intel's seventh-generation Core processor datasheet, your CPU's HD Graphics display controller supports up to HDMI 1.4 and DisplayPort 1.2. That's why the chip can do 4096x2304 at 24Hz over HDMI, but 4096x2304 at 60Hz over DisplayPort. For the best experience, then, keep using DisplayPort.

Adding a graphics card won't improve picture quality beyond what Intel's on-die engine provides. In fact, technologies like QuickSync may favor using HD Graphics if your favorite apps are optimized for them.

## Gigabit-Class Internet

Doc, I recently found that I'm lucky enough to be getting Gigabit-class Internet where I live. However, this good fortune causes a conundrum. With my newfound bandwidth, I'd like to build a server to do things such as NAS, Plex, and dedicated game hosting for myself and friends.

I have no idea what type of hardware I should be looking at, though. I've been leaning toward a Ryzen 3 or 5 with 16GB of RAM, but am not sure if this is overkill. I have a Radeon HD 7950 kicking around for transcoding, so that should be sufficient for graphics processing, right?

Any recommendations? I also need the motherboard to fit a Mini-ITX form factor. **–Casey Bedford**

**ASRock's Fatal1ty AB350 Gaming-ITX/ac offers loads of functionality for Ryzen CPUs.**

**THE DOCTOR RESPONDS:** Color the Doc jealous, Casey. Gigabit connectivity sounds divine. But it's tough to generalize the best specs for your server without knowing how hard you'll hit it.

Plex recommends a Core i3 at minimum. However, the software runs on many NAS appliances, if that helps put its performance requirements into context. Those devices typically employ embedded CPUs without much processing power. Granted, Plex's NAS compatibility list is riddled with models that struggle with high-bitrate standard-def media, so 720p and 1080p streams are even more of a challenge. A Ryzen 3 or 5 might be what you need for transcoding to remote devices when away from home. Alternatively, consider a Core i3 or i5 with QuickSync tech for hardware-accelerated encode/decode. That's a far more efficient solution than an old Radeon HD 7950 (which may not even be officially supported).

Any build capable of handling Plex's most CPU-intensive operations will have little trouble functioning as a general-purpose NAS. Running a game server might be more taxing. Though again, a mainstream CPU, lots of RAM, and enough solid-state storage to avoid becoming I/O-bound should be fine. It's better to over-build than to battle workarounds for performance deficiencies down the road.

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- NVIDIA® GeForce™ GTX 1050Ti 4GB GPU
- 8GB DDR4-2400MHz Memory
- 1TB 5400RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Intel® Dual Band Wireless-AC + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
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# STREAMLINE & OPTIMIZE WINDOWS

*Alex Cox* shows you how to cut out everything you don't need, and create a custom Windows install for next time

**BLOAT IS THE CURSE** of operating systems, because they need to appeal to the masses, rather than cater for individuals. You can't have a Microsoft engineer sit there and craft you your own custom version of Windows (we know, we've asked), so you need to scrape off that additional chaff yourself. We're not just talking about shaving away the contents of a couple of megabytes of hard drive space, or cleaning up the Start menu. Windows comes with stacks of software that can reduce your machine's performance or boot time. It comes with stuff that can see what you're doing. It includes features that are potentially monumentally annoying. So we'll do away with all of them, plus explain what's safe to chop, and what isn't.

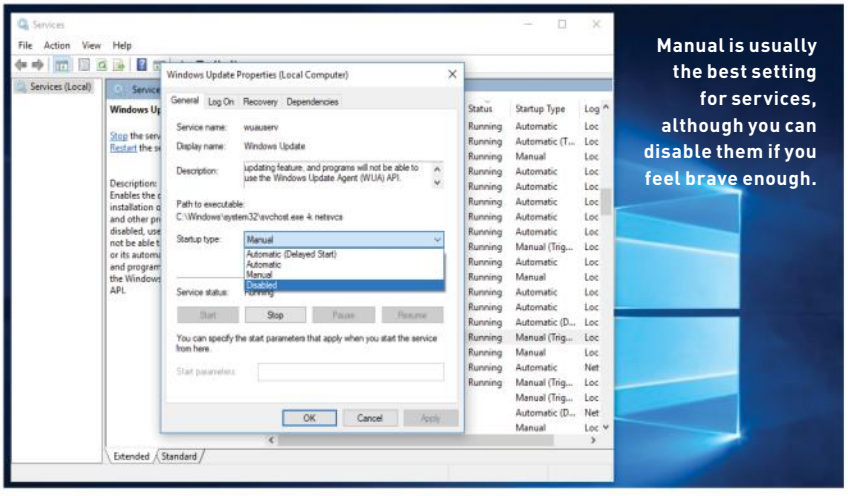
Doing all this work every time you get a new PC would be very frustrating, so we're also going to look at creating an already-mostly-trimmed Windows installer, which you can use to start from a much more advanced point than usual, and even integrate apps that make up for some of Windows 10's shortfalls. A better Windows for your PC of tomorrow. And before you write in to say that you can do the picking, choosing, scrubbing, building thing with Linux, rest assured: we know. Building your own Linux installation is a completely different kettle of fish, it's more common, and better supported, and it's a topic for another feature. Windows doesn't seem to encourage trimming, but a little knowledge goes a long way. Our sacrificial OS for this guide is the latest official ISO of Windows 10 Home, updated for the Creators Update, because (presumably) that's the version most people are using; if you're taking a hammer to the Pro version, you might have to tease out a few more services, but the changes won't be too extreme.

CHROMAX
SAMSUNG
Solid State Drive
NZXT

## UI OVERHAUL

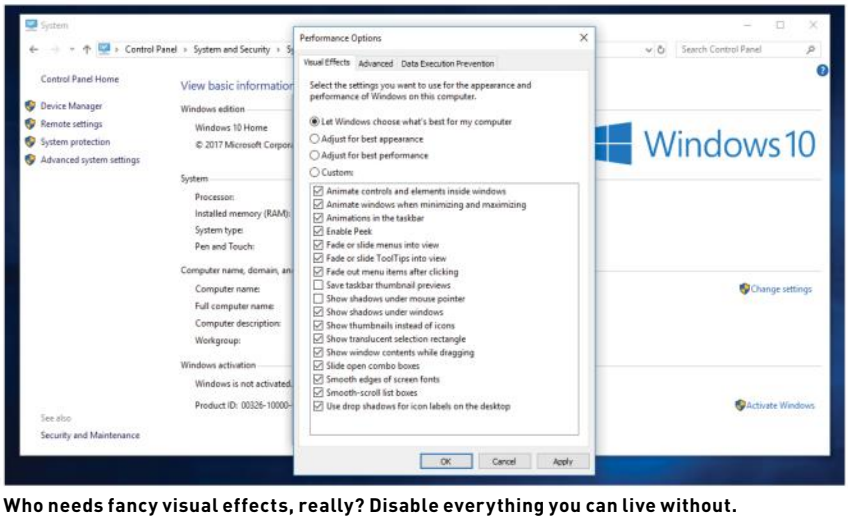
Although Windows 10's interface is already a highly streamlined affair compared to its predecessor, it could stand to be slicker. Let's begin, with our clean Windows install, by making it snappier, removing unnecessary elements, and making that experience all the better. What better place to start than, well, Start itself? In our minds, there's nothing more pointless than Windows 10's Start menu tiles. Windows 10 Pro includes tools such as the Group Policy Editor, which can help you do away with them quickly, but in Home you're stuck with the tedious process of right-clicking each tile, and selecting "Unpin from start." Do this enough times, click off the Start menu, and relaunch it, and that pesky right side panel disappears altogether. Clearing out the main bulk of the menu itself, apart from a certain selection of Windows' default apps, is again a case of wading in with right-clicks, and uninstalling. Those apps that simply won't uninstall—the monsters—can usually be excised using Powershell. See the "Ultimate Removal" box (pg. 31) to find out how to remove and, if you're desperate, reinstate them.

There is a host of surface personalization tweaks that you can apply to the Start menu and Taskbar through the "Settings → Personalization" menu. You can change the color by first selecting an accent color in "Colors," then checking the box to apply it to the Start menu, Action Center, and Taskbar. While you're on the same screen, switch off transparency effects for a microscopic performance boost, then head to the "Start" tab. Because we're old school, we favor switching off everything here to make the Start menu a straight alphabetized list of apps, but we're not going to say you're wrong if you like having recently used or installed apps pushed to the top. Suggested apps, though? That can definitely go. At the bottom of the page, click "Choose which folders appear on Start" to get quick links to a bunch of useful features on there. Quite why File Explorer and its ilk aren't included by default is baffling.


Windows Update Properties (Local Computer)
Manual is usually the best setting for services, although you can disable them if you feel brave enough.

Basic stuff done, let's do some more intricate tweaking. Open up "Control Panel → System and Security → System → Advanced system settings," then click the "Advanced" tab. Jump into the performance settings, and switch off everything you can't stand to lose. Since we're currently here for efficiency, not looks, we recommend disabling animations, fades, shadows—basically, everything bar font smoothing. Save your changes, then open up the Registry editor for a quick deeper hack. Navigate to the "HKEY_CURRENT_USER\Control Panel\Desktop" key, open up the "MenuShowDelay" entry, and change its value. A flat zero tends to make things a little overcrisp (read: impossible to use), but halving the number can really make Windows feel a lot more responsive.

**Tweaking colors is only aesthetic, but can help Windows feel more streamlined.**




**Who needs fancy visual effects, really? Disable everything you can live without.**

## BACK TO BASICS

Now head back to the control panel, because it's time to do a little old-school scrubbing. Head to "Programs → Programs and Features," and select "Turn Windows features on or off." The list isn't over-extensive, and there's not much you can remove that'll leave you with a faster PC, but it can prevent some annoyances. Drop, for example, Internet Explorer 11, because you don't use it, and there's no sense keeping it around. You can also kill off Windows Media Player, if that's not your jam. And if you're feeling adventurous, you could switch on Windows Subsystem for Linux, and head to the "Streamline Your Shell" box (pg. 30) to see why you should be using it.

Next, let's improve our boot speed by preventing a few things from running at startup. Launch the Task Manager with Ctrl-Shift-Esc, and head to the "Startup" tab. Each program that's launched automatically is listed with a broad rating of its start time impact. If there are

**Removing those pesky live tiles is as simple as a right-click.**

components here that you use very little, it's a good idea to stop them; to squash OneDrive's system-grinding initial launch time, for example, right-click it, and set its status to "Disabled." For more intricate control, Microsoft's Sysinternals team has long published Autoruns, a free (and portable) add-on that offers access to the same management tools as Task Manager, plus a whole lot more.

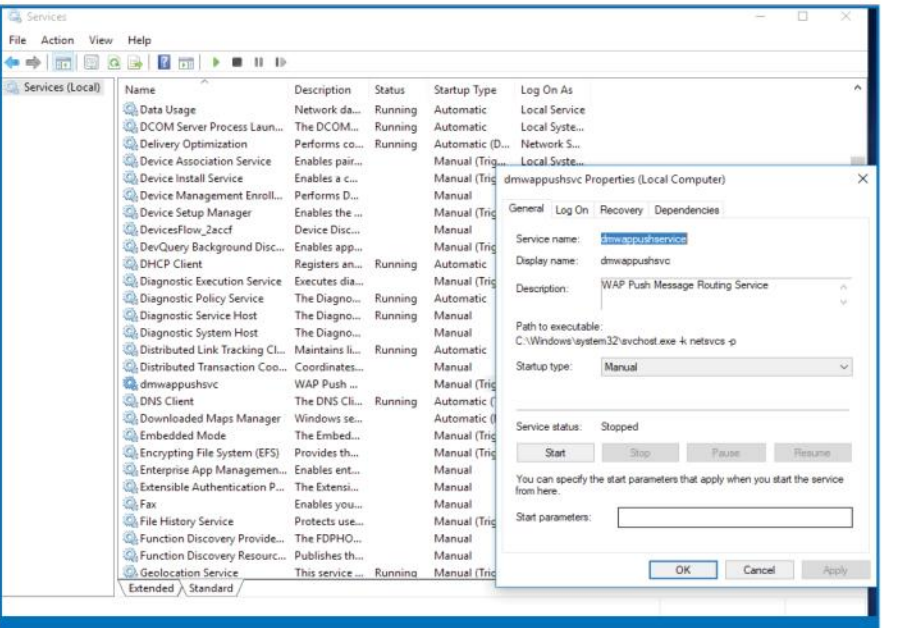
More classic cleaning can be done within Windows 10's Settings screen. Microsoft's love for its Universal apps means it presumes you'll want to use them, and are going to want them ready at a moment's notice, running in the background at all times. Which may be true, but it's more likely that disabling those background apps is preferable. In "Privacy → Background Apps," you can switch off anything you're happy to just fire off manually, which will likely include, well, just about everything.

One more quick optimization, whether you're running a small drive or not, would be to clean up temporary files, and wash away old versions of Windows. This will gain a fraction more speed in certain apps if they're forced to grind through cache directories before running, but you're not doing this just for speed; you're doing it for cleanliness. Find the drive you want to optimize in File Explorer, right-click it, select "Properties," then seek out "Disk Cleanup" in the "General" tab. Select the categories you want to kill, and use "Clean up system files" to expunge the lot.

## SLASHING SERVICES

We are, of course, working on a clean Windows install, but you probably aren't. Disabling the core Windows services—those programs that run quietly in the background, supplying your PC with essential (and inessential) functions that don't require a UI—isn't necessarily recommended; Microsoft's own suite has been honed over the years to be as efficient as possible, its contents sitting in the pagefile, barely ever touching system RAM. You could chop out most Windows services and never feel a difference on a modern PC, apart from the whole operating system crumbling around your ears. Third-party services, though, are a different story, and cutting them out means you're likely to see a real change, which (usually) will only impact that app's time to initial launch.

First up, finding out what's running. The Task Manager is a good place to start. Switch to the Advanced view, and scroll down to see the entries prefixed with the words "service host." These are all fired off via svchost.exe, so they're categorized together. Some might contain more than one service, which you can discover by clicking the expand arrow on the left; and most, while not essential, are there to improve your Windows experience. A quick glance through the list in our clean install reveals Superfetch as the main culprit for RAM hogging—as it should be, given that it's the service that puts commonly accessed data into RAM, rather than spending ages reading it from the hard drive. Our biggest CPU sapper is the usefully named


Services
File Action View Help
Services (Local)
Name Description Status Startup Type Log On As
dmwappushsvc Properties (Local Computer)
General Log On Recovery Dependencies
Service name: dmwappushservice
Display name: dmwappushsvc
Description: WAP Push Message Routing Service
Path to executable:
C:\Windows\system32\svchost.exe -k netsvcs -p
Startup type: Manual
Service status: Stopped
Start Stop Pause Resume
You can specify the start parameters that apply when you start the service from here.
Start parameters:
OK Cancel Apply
Extended Standard

## SAFE SERVICES

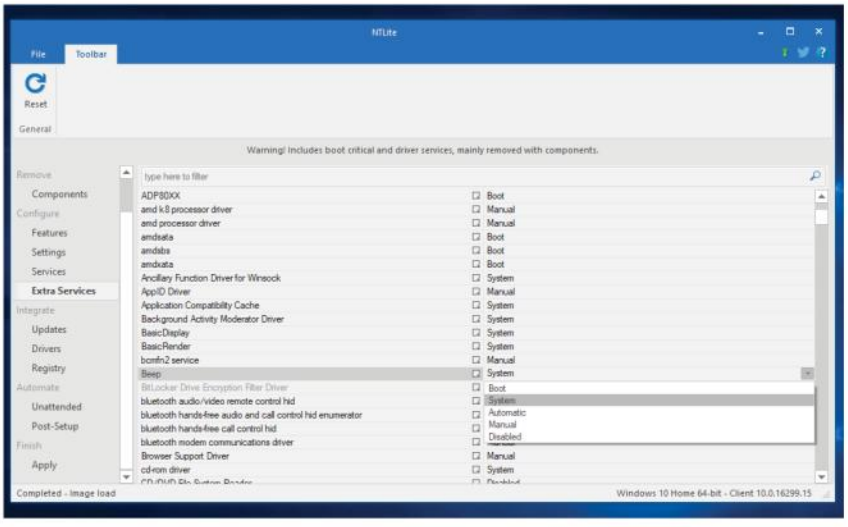
There's a laundry list of services that can safely be switched from automatic to manual for a boost at boot time; disabling them altogether is a question of your preferences, or Windows' ability to hold up. Cut **Connected User Services and Telemetry, dmwappushsvc,** and **Diagnostic Tracking Service** to remove Windows' spying—er, telemetry—tendencies, then **Diagnostic Policy Service, Windows Error Reporting Service,** and **Program Compatibility Assistance Service** to do away with a few services that you won't want bothering you once you've started tearing Windows to shreds. Disable **Remote Registry** just to be a little secure, and **Windows Defender Service** (and possibly **Security Center**) if you're confident in your own malware-fighting methods.

A lot of the other possibilities will depend on the specific makeup of your machine. Shut down **IP Helper** if you're not using IPv6, **TCP/IP NetBIOS Helper** if you're not part of a workgroup, or **Distributed Link Tracking Client** if your PC is not on a network at all. Kill **Print Spooler** if you don't have a printer, **Windows Image Acquisition (WIA)** if you're scannerless, **Touch Keyboard and Handwriting Panel Service** if you don't have a touchscreen, **Bluetooth Support** if you haven't already got the idea here, and **Downloaded Maps Manager** if you never use Windows' built-in maps app.

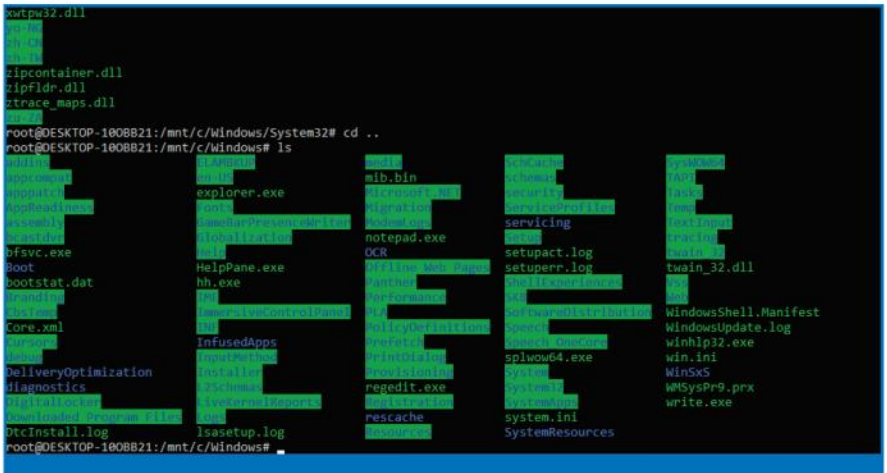
You may also wish to make a few other services manual, without disabling them. The three remote desktop services are optional, and your graphics card (or possibly sound driver) has likely slipped a few in. Dropping these to manual will improve boot time, but probably slow the launch of your graphics-intensive apps. That's a common theme with services: Unless you completely disable them, you simply delay the, er, delay, and disabling is rarely the best idea. But do experiment, and see what works for you.

"Local System," which basically deals with Windows updates. But that's the perfect target for now: We know there are no updates pending, so we can stop it.

Clumsily ending the task in Task Manager won't do. Instead, type "services" into the search bar to open the services section of Windows' Management Console. You won't find "Local System" in the list, but you should find the two components we're looking for: Windows Update, and the Update Orchestrator service. Right-click them, select "Stop," and they'll go away until your next boot. Those sanctions not harsh enough? Right-click, select "Properties," and poke around the "General" tab. Change the "Startup type" to "Disabled," and they won't come back until you dig through the list and switch them back on again. Be warned, though: Unless Windows is happy to do without, this a stupid thing to do. Even more stupid (but similarly possible) would be to remove a Windows service altogether, although cutting out a third-party service (maybe even a piece of malware) is unlikely to sting too much. Run the Registry editor by typing "regedit" into the search bar, then dig down to "HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/Services." Finding the particular service you want to kill can be tricky, but click around until you find it, then rename (or, ulp, delete) its key to get rid.




**NTLite enables you to drop integrated services before Windows is even installed.**




## STREAMLINE YOUR SHELL

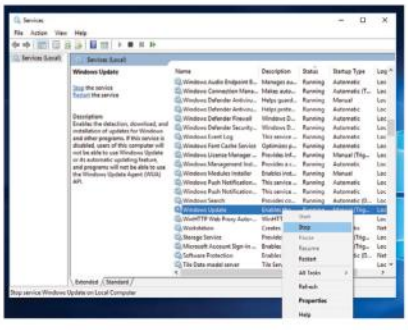
Windows' recent softening on the Linux shell wasn't so much controversial as it was surprising; it's a subtle acknowledgement that many power users prefer the efficiency and depth of the likes of Bash over the sometimes clumsy world of the creaking DOS-derived Windows shell. And it almost happened by accident. Microsoft was working on technology to allow Android apps to run on Windows, and the Linux Subsystem—not an emulator, but a native interpreter—is what resulted.

To get yourself up and running, first go to "Settings → Update & Security → For Developers," and switch on Developer mode. Then enable the appropriate subsystem in the "Programs and Features" section of Control Panel. Once you've rebooted your machine, open up a command prompt as administrator, and type **lxrun /install /y** to automatically install the Ubuntu flavor of the Bash shell. Once it's all gone in, you'll be able to open up the Linux shell by typing **bash** into the search box.

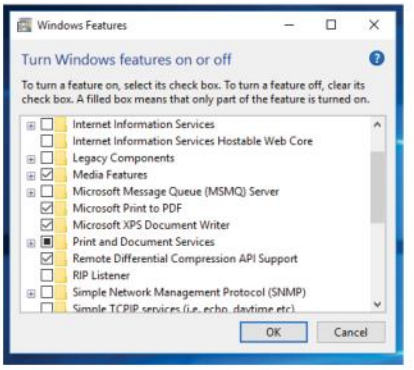
So, why would you want to use the Linux shell? First, there's the simplicity of navigation. You can use **ls** to list a directory, **rm** to remove files or folders, and **mv** to move or rename files. Once you're used to it, the shell can be a faster and more efficient way to shift files around than even the stock Windows File Explorer. Then there's access to the core Bash apps, often packed with much more detail and usage options than their Windows counterparts. And you're not just stuck with the base shell—by using Ubuntu's apt-get package manager, which comes as part and parcel of the installation, you can add new applications and functions with a single command.

### BACK IN TIME

If you're installing on a new machine, there's no reason you have to use Microsoft's stock ISO. Installation customization tool NTLite actually makes generating a stripped-down Windows easier, and it means you can arguably do a lot more in a lot less time. It's also a chance to save a bunch of time post-install, as you can integrate all the drivers, updates, and software you need into your custom installer, so it's there straight away. What's more, it's a fantastic way of cutting down an existing Windows installation, as long as you pay for a license—although



**You can use "Stop" to temporarily kill a service and see what effect it has.**


Windows Features
Turn Windows features on or off
To turn a feature on, select its check box. To turn a feature off, clear its check box. A filled box means that only part of the feature is turned on.
Internet Information Services
Internet Information Services Hostable Web Core
Legacy Components
Media Features
Microsoft Message Queue (MSMQ) Server
Microsoft Print to PDF
Microsoft XPS Document Writer
Print and Document Services
Remote Differential Compression API Support
RIP Listener
Simple Network Management Protocol (SNMP)
Simple TCPIP services (i.e. echo, daytime etc)
OK
Cancel

**Disabling Windows features is a good idea if you're never going to use them.**

you'll only be able to create your own install image if you're chipping away at an ISO, rather than a running system.

Let's concentrate on trimming a new ISO—the live process is no different, just a little more narrow. Download the software from www.ntlite.com via the three-line hamburger menu, and run through its installer—you can also create a portable version of NTLite at this point by checking the appropriate box, so you can drop it on a USB drive, and take it from machine to machine if necessary. Before you run it, mount your Windows ISO (you can download one from the Microsoft website, if you don't have one handy) by right-clicking the file, and selecting "Mount," then copy over the files to a writable folder to prepare them before unmounting again. Open NTLite, click the "Add" button on the ribbon, and point it at the folder where you dropped your installer files. Pick the version of Windows you're looking to hack, wait for it to mount (it may take a couple of minutes), then select "Components" below "Remove" in the left column, and accept the dire warning of potential doom that appears.

The full list of features available for removal is going to be pretty daunting, and unless you're generating a kiosk Windows that's designed to be impervious to interference by certain means, there's probably little reason to go too crazy here—you can cut out some of the same services that you might have disabled previously, and really trim the size of your ISO by excluding support for every piece of hardware you know you don't have. You'll see a bunch of stuff in blue—these are components that you can't remove unless you cough up €40 (about $47) for a full license.

Check out the "Settings," "Services," and "Extra Services" panels, too. The former enables you to preconfigure your ISO to look and act just as you'd expect, again saving you time poking around the Settings screen and Control Panel later on, while the latter pair gives you full control over services, as discussed previously. "Extra Services," in particular, enables you to manipulate a bunch of services that would usually be pretty inaccessible through Windows itself; switching some of these from "Boot" to "Manual" can boost your boot time, although you won't know until you install your image, so this may be a false economy. The "Integrate" and "Automate" categories are where you include the software and drivers you want to integrate into your new ISO—anything third-party needs to go in the "Post-setup" section.

When you're done, use the "Apply" section at the bottom of the list to finish everything off. We recommend opting for the "Save and trim" option, which cuts out everything but the specific version of Windows 10 you've been working on. As most ISOs contain multiple editions, and few people have any use for Windows 10 S, N, and the like, this is a good way to cut down the size of the install image.

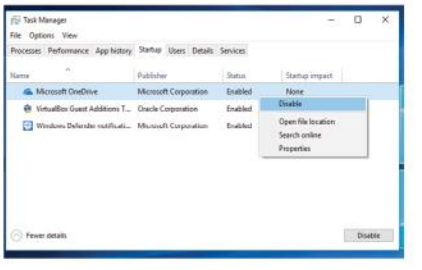
```
InstallLocation    : C:\Program Files\WindowsApps\microsoft.windowscommunicationsapps_17.8730.21155.0_x64__8wekyb3d
IsFramework        : False
PackageFamilyName  : microsoft.windowscommunicationsapps_8wekyb3d8bbwe
PublisherId        : 8wekyb3d8bbwe
IsResourcePackage  : False
IsBundle           : False
IsDevelopmentMode  : False
Dependencies       : {Microsoft.VCLibs.140.00_14.0.25426.0_x64__8wekyb3d8bbwe}
IsPartiallyStaged  : False
SignatureKind      : Store
Status             : Ok

Name               : Microsoft.Advertising.Xaml
Publisher          : CN=Microsoft Corporation, O=Microsoft Corporation, L=Redmond, S=Washington, C=US
Architecture       : X64
ResourceId         :
Version            : 10.1712.2.0
PackageFullName    : Microsoft.Advertising.Xaml_10.1712.2.0_x64__8wekyb3d8bbwe
InstallLocation    : C:\Program Files\WindowsApps\Microsoft.Advertising.Xaml_10.1712.2.0_x64__8wekyb3d8bbwe
IsFramework        : True
PackageFamilyName  : Microsoft.Advertising.Xaml_8wekyb3d8bbwe
PublisherId        : 8wekyb3d8bbwe
IsResourcePackage  : False
IsBundle           : False
IsDevelopmentMode  : False
IsPartiallyStaged  : False
SignatureKind      : Store
Status             : Ok

Name               : Microsoft.Advertising.Xaml
Publisher          : CN=Microsoft Corporation, O=Microsoft Corporation, L=Redmond, S=Washington, C=US
Architecture       : X86
ResourceId         :
Version            : 10.1712.2.0
PackageFullName    : Microsoft.Advertising.Xaml_10.1712.2.0_x86__8wekyb3d8bbwe
InstallLocation    : C:\Program Files\WindowsApps\Microsoft.Advertising.Xaml_10.1712.2.0_x86__8wekyb3d8bbwe
IsFramework        : True
PackageFamilyName  : Microsoft.Advertising.Xaml_8wekyb3d8bbwe
PublisherId        : 8wekyb3d8bbwe
IsResourcePackage  : False
IsBundle           : False
```

## ULTIMATE REMOVAL

Doing Windows your way means only including the applications you absolutely want, using Windows as a base for your operations, and often completely ignoring those apps that Microsoft doggedly protects unwitting users from deleting. We're not suggesting they're useless, and sometimes a core Windows app might be the best choice, but that's for you to decide.

While the surface parts of Windows deny their removal, the deeper toolbox doesn't. Fire up Powershell by right-clicking the "Start" button, and selecting "Windows Powershell (Admin)." Now run the command **Get-AppxPackage** (capitalization is important in Powershell) to list every core app that Windows has installed. Scroll through—it's probably quite a long list—until you find the application you're looking for, and seek out its full name, which is a longer string, including version numbers. Then just type "Remove-AppxPackage <full name>" to strike it from your drive.

One bit of caution here: Don't, whatever you do, remove the Windows Store app. While most of these apps can be reinstalled relatively simply if you realize you've made a mistake, removing the Windows Store removes it permanently, and also does away with your ability to reinstall other core apps. Whatever you may think of the Windows app pool, the Store itself is getting at least a bit better these days, and you don't have to use it. Just work around the fact that it's still there. This may not be an entirely permanent exercise, either. Future updates are likely to reinstall packages that you've previously removed, and add a few stubborn newcomers to the mix along with them. But now you know how to remove them, you can just go through the process afresh when major new versions of Windows appear.




**Dropping little-used startup apps can lead to a much faster boot.**

Intel's interposer-beating EMIB technology is a key enabler.

# AMD INSIDE

## An unholy alliance or the inevitable next step? Jeremy Laird investigates Intel's new processor that includes a high-performance AMD GPU

**AN AMD GRAPHICS CHIP** inside an Intel processor? Not in a million years. But that is precisely what Intel recently announced: a whole new product line that combines an Intel CPU with an AMD GPU in a single processor package.

More specifically, it contains a quad-core CPU and a high-performance AMD GPU. The new chip is intended to enable the creation of a new generation of thin and light laptops with serious performance. Enough performance to play AAA games, deliver a quality VR performance, and support pro-level content creation.

If it seems like an unholy alliance between confirmed enemies, there are not only major upsides for both Intel and AMD—the new chip also represents the logical next step for the PC as a platform in both mobile and desktop forms. However, it being a logical next step does not necessarily mean the eventual outcome will be predictable. Intel and AMD's alliance will almost certainly revolutionize both the physical architecture of the PC and the key relationships that have defined the industry for a generation. If the impact the new technology will have on the PC

as a device is straightforward to grasp, it's far from clear how the balance of power between the major players will shake out.

For starters, if the fusing of CPU and GPU functions into a single package is the future of not just entry level systems but high-performance content-creation and gaming PCs, does this mean Intel will be reliant on AMD's help going forward? Likewise, missing so far from this picture is the final member of the uneasy triumvirate that rules the PC: Nvidia.

At first glance, this development doesn't look good for Team Green. Nvidia currently lacks an obvious route to do something similar, and insert its graphics technology on to a CPU package. In the long run, if this new CPU-GPU approach ends up being the default configuration for performance PCs, it certainly seems like Nvidia won't have a place at the table. But, as we'll see, there's much to play for. This is just the first move.

Are the political machinations that have enabled this new Intel-AMD mega chip to exist more interesting than the technical details? That might just be true, but let's start by squaring away the details of what Intel announced, and also consider some of the secrets regarding its specifications that have since emerged.

## THE POWER WITHIN

The basics involve a single processor package that combines four major elements. The first two are the previously mentioned Intel CPU and AMD GPU. Intel says that the CPU is one of its Kaby Lake generation Core H series mobile chips. That indicates a quad-core processor somewhat incongruously equipped with its own integrated graphics functionality.

It's possible Intel has created a new spin on the Kaby Lake Core H, with the integrated graphics stripped out. However, given this is initially aimed at creating thin and light laptops, there are clear benefits to keeping the Intel integrated graphics. It allows for low-power operating modes and extended battery life when full graphics performance from the AMD GPU isn't required. The probability, then, is that the CPU part of the package is more or less straight off Intel's shelf. Hold that thought.

Part two is the AMD Radeon graphics. This is where the bespoke engineering begins. Our understanding is that the AMD GPU is a custom chip created expressly for Intel. In fact, it has to be precisely that, based on further elements we'll come to shortly. What it isn't, however, is a radically advanced chip from a 3D rendering perspective. It's listed in leaked specfication sheets as an AMD Vega M GH Graphics GPU, although what that actually means isn't totally clear at this point.

Specification and benchmark leaks involving some early development systems based on the new CPU-GPU package suggest some further details for the specs of the graphics part of the package. Two iterations of the product have been seen, known as the Core i7-8705G and the higher performing Core i7-8809G. In top spec, the AMD GPU looks to be a 24 compute unit item. Two variants have been seen in the wild: one with a GPU clock speed of 1GHz, the other 1.2GHz. Do the math on the compute units, based on existing AMD GPUs, and you have 1,536 unified shaders.

For context, AMD's Radeon RX 480 has 2,304 shaders, and the most powerful RX 470 cards have 1,792 shaders. Of course, neither of those are close to being AMD's top-performing GPUs, which are based on the newer Vega architecture. Another interesting reference point involves games consoles. Both the Sony PlayStation and Microsoft Xbox now use AMD graphics technology, albeit from a slightly earlier generation of AMD graphics than Polaris. The original Xbox One boasted 768 unified

## GAME OVER FOR NVIDIA?

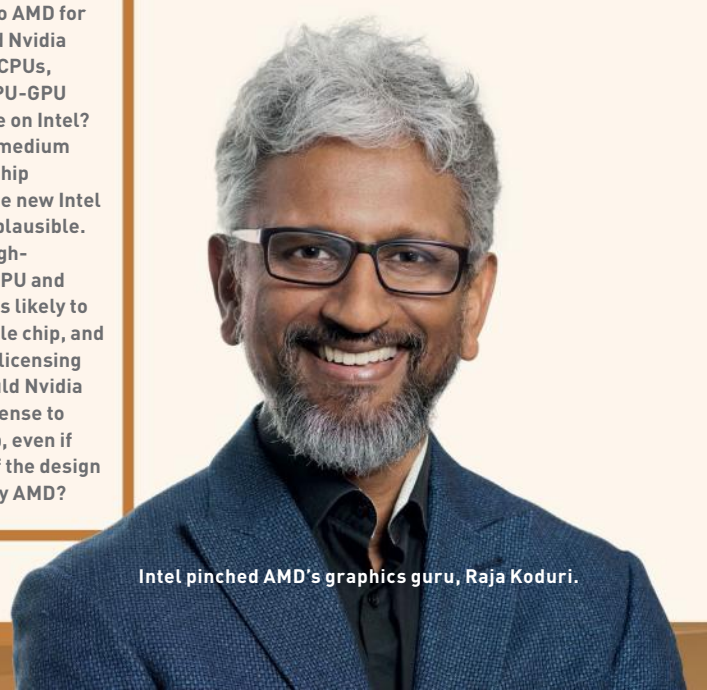
Is this unholy alliance between Intel and AMD the beginning of the end for Nvidia? At first glance, it looks as though Nvidia simply cannot respond. It doesn't make x86-compatible PC processors, and it lacks the required license to do so, even if it wanted to. It seems very unlikely that Intel would pair with Nvidia on a CPU-GPU product. Likewise, why would AMD put Nvidia graphics into a package when it has its own high-performance GPU architectures?

When you think about it, Nvidia can only sell graphics to consumers because Intel and AMD allow it. It's Intel and AMD that control the platforms and the interfaces that allow GPUs to communicate with CPUs. Eventually, these new CPU-GPU packages may come to dominate the market, with both Intel and AMD doing their own versions based on 100 percent in-house processor and graphics technology. In this scenario, Nvidia is a goner. It has no relevant x86-compatible PC processor technology to call upon.

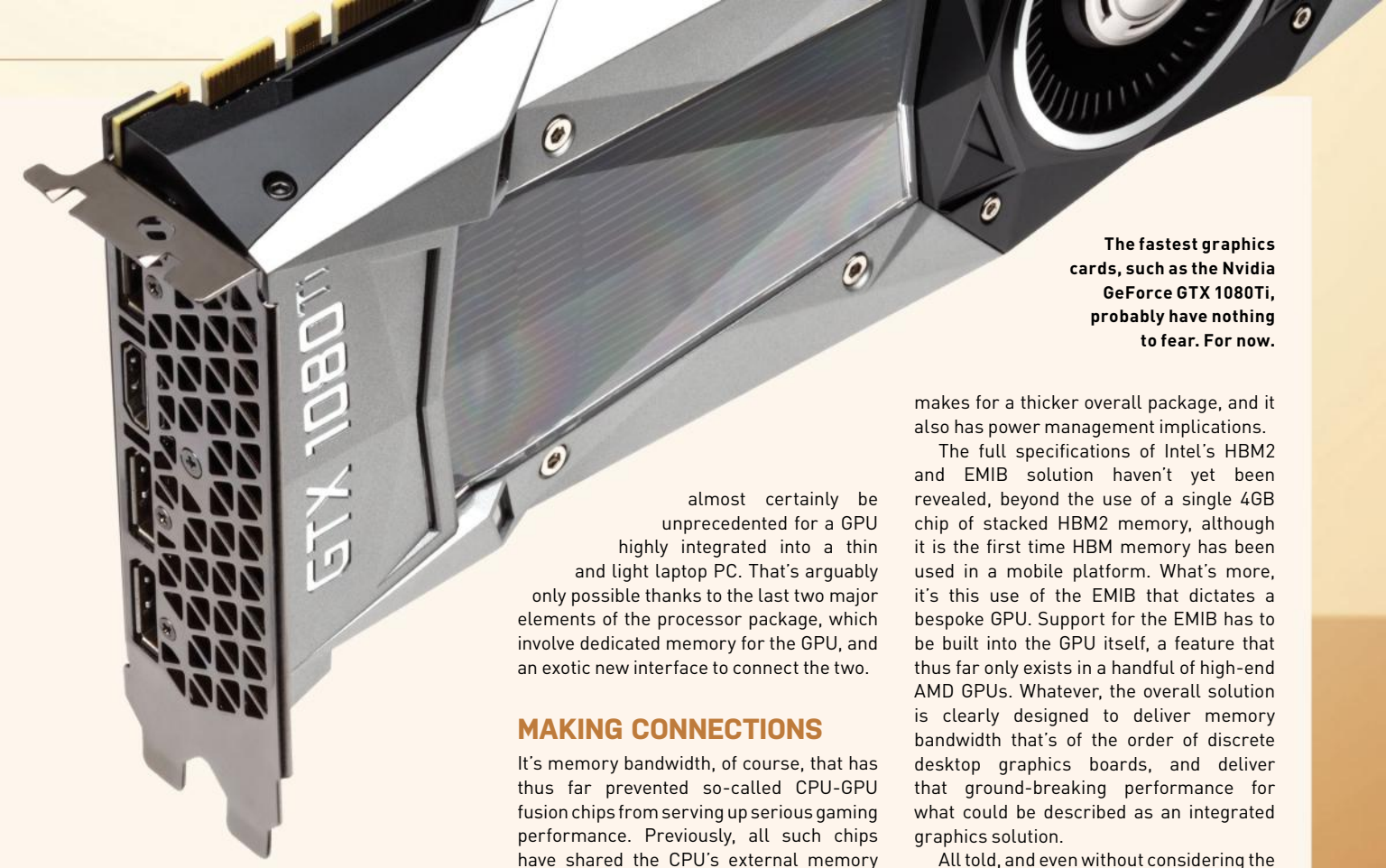
But hang on: Nvidia is hardly dumb to this possible end game. That's no doubt why it has pushed hard in recent years to broaden its horizons. ARM chips, chips for conventional cars today and autonomous cars tomorrow, industrial parallel compute through general-purpose GPU products—Nvidia has been working hard on all of this, and more.

On the one hand, it could all come down to how hard Intel will push this new high-performance CPU-GPU paradigm, and how quickly the rest of Nvidia's business can grow to replace dwindling consumer graphics sales. In that case, it's all rather ironic, given the current strength of Nvidia's consumer GPU business, and the rosy outlook for PC gaming in general.

But here's the catch: If Intel can go to AMD for graphics, could Nvidia hit up AMD for CPUs, and create a CPU-GPU package to take on Intel? In the short to medium term, a multi-chip package like the new Intel product looks plausible. Further out, high-performance CPU and GPU tech seems likely to fuse into a single chip, and that may raise licensing problems. Would Nvidia need an x86 license to sell such a chip, even if the CPU part of the design was supplied by AMD?



Intel pinched AMD's graphics guru, Raja Koduri.




**The fastest graphics cards, such as the Nvidia GeForce GTX 1080Ti, probably have nothing to fear. For now.**

shaders, while the much-improved Xbox One X packs 2,560 shaders. The new Sony PlayStation 4 Pro, meanwhile, rocks 2,304 shaders.

Anyway, factor in the clock speeds of the higher performing Core i7-8809G (which may be far from final), and the resulting performance of the CPU-GPU package from a gaming perspective likely falls somewhere between the Nvidia GeForce GTX 1050 Ti and 1060 desktop graphics chipsets. A solid gaming proposition to be sure, especially for a mobile platform, if somewhat marginal, given that Intel has specifically called out VR gaming as a core competence for the new product. That's either a stretch by existing metrics of what constitutes VR-capable games performance (the GTX 1060 is pretty much a bare minimum), or Intel may have more powerful versions of the new product that have yet to be spotted in the wild.

Of course, however the precise performance eventually turns out, it will almost certainly be unprecedented for a GPU highly integrated into a thin and light laptop PC. That's arguably only possible thanks to the last two major elements of the processor package, which involve dedicated memory for the GPU, and an exotic new interface to connect the two.

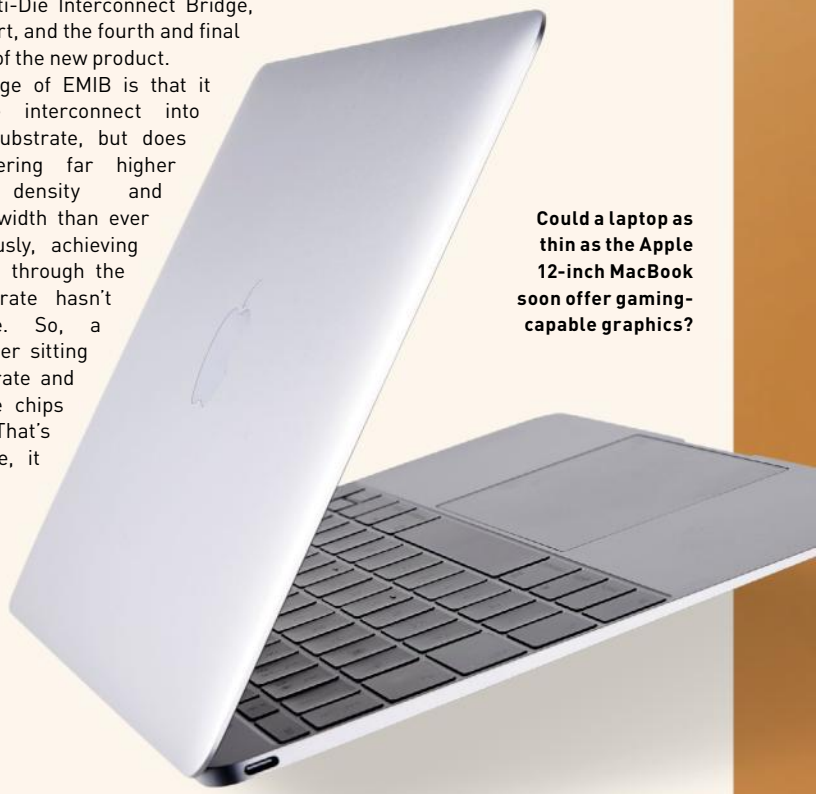
## MAKING CONNECTIONS

It's memory bandwidth, of course, that has thus far prevented so-called CPU-GPU fusion chips from serving up serious gaming performance. Previously, all such chips have shared the CPU's external memory controller with the GPU, and that has meant frankly pitiful memory bandwidth by GPU standards. But Intel's new beast has a full 4GB of stacked High Bandwidth 2, or HBM2, memory hooked up to the GPU via its own proprietary interconnect, known as the Embedded Multi-Die Interconnect Bridge, or EMIB for short, and the fourth and final major element of the new product.

The advantage of EMIB is that it integrates the interconnect into the package substrate, but does so while offering far higher connectivity density and therefore bandwidth than ever before. Previously, achieving high bandwidth through the package substrate hasn't been possible. So, a silicon interposer sitting atop the substrate and underneath the chips has been used. That's more expensive, it makes for a thicker overall package, and it also has power management implications.

The full specifications of Intel's HBM2 and EMIB solution haven't yet been revealed, beyond the use of a single 4GB chip of stacked HBM2 memory, although it is the first time HBM memory has been used in a mobile platform. What's more, it's this use of the EMIB that dictates a bespoke GPU. Support for the EMIB has to be built into the GPU itself, a feature that thus far only exists in a handful of high-end AMD GPUs. Whatever, the overall solution is clearly designed to deliver memory bandwidth that's of the order of discrete desktop graphics boards, and deliver that ground-breaking performance for what could be described as an integrated graphics solution.

All told, and even without considering the politics of the Intel-AMD relationship, it's fascinating from a technical perspective. The big question is whether it represents a glimpse of the future. Is this what not only laptops but also desktop PCs will look like in the future? That's been the assumption



**Could a laptop as thin as the Apple 12-inch MacBook soon offer gaming-capable graphics?**

The performance likely falls between the Nvidia GeForce GTX 1050 Ti and 1060.

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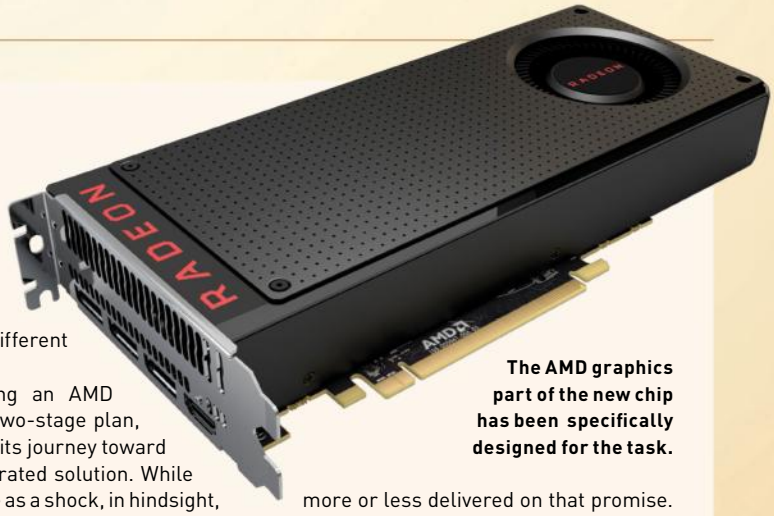
# What would motivate AMD and Intel to get into bed like this?




**The AMD graphics part of the new chip has been specifically designed for the task.**

ever since Intel first integrated graphics into its CPU packages, but thus far, such fusion processors or APUs have been a low-cost solution. This is the first time that anyone has taken a genuine tilt at creating a single-package product with bona fide gaming and content creation capabilities.

While we wait to discover just how fast it will be, and just how thin and light the laptops are that it enables, the question of what it all means for the industry is plenty to keep us going. What would motivate AMD and Intel to get into bed like this? The answer to that is different for each company.

For Intel, using an AMD GPU is part of a two-stage plan, and a shortcut on its journey toward an in-house integrated solution. While the news did come as a shock, in hindsight, Intel's integrated strategy has hinted at a move like this for a while. When Intel originally put graphics cores into its CPUs, bold claims were made for progressing 3D rendering performance with each successive iteration. For a while, Intel more or less delivered on that promise. More recently, progress has slowed, and it became clear that Intel's in-house graphics architecture had lost momentum. What's more, while Intel's integrated graphics performance improved, so did the performance of discrete 3D cards. Likewise, PC games only become more graphically demanding over time. The upshot is that Intel's integrated graphics are no closer today to being truly gaming capable than they ever were. Something had to change.

## RIVAL REVELS

In the long run, the plan for Intel is to totally reboot its own graphics tech by creating its own competitive high-performance 3D architecture (see boxout, left). In theory, having its own competitive in-house graphics means Intel will eventually be able to create single-package solutions based exclusively on its own technology. In the meantime, however, Intel simply didn't have suitable graphics technology to make a high-performance product possible. That Intel nevertheless felt compelled to press on and was willing to use technology supplied by its arch rival AMD very likely points to the other major factor providing motivation: Intel wants to hurt and just maybe kill Nvidia.

Currently, Nvidia absolutely dominates the market for consumer discrete graphics chips. It sells around three quarters of such products bought by consumers, with AMD picking up the rest. That's a high value market in its own right. It's also a market that's growing while the rest of the PC continues its gentle decline. Jon Peddie Research reckons the market for gaming PCs hit $30 billion for the first time in 2016, well up on the estimated $24.6 billion the market accounted for in 2015.

As Jon Peddie Research says, "The average PC sale is increasingly motivated by the video game use model, which is important to understand in a stagnant

## INTEL'S GRAPHICS PLANS

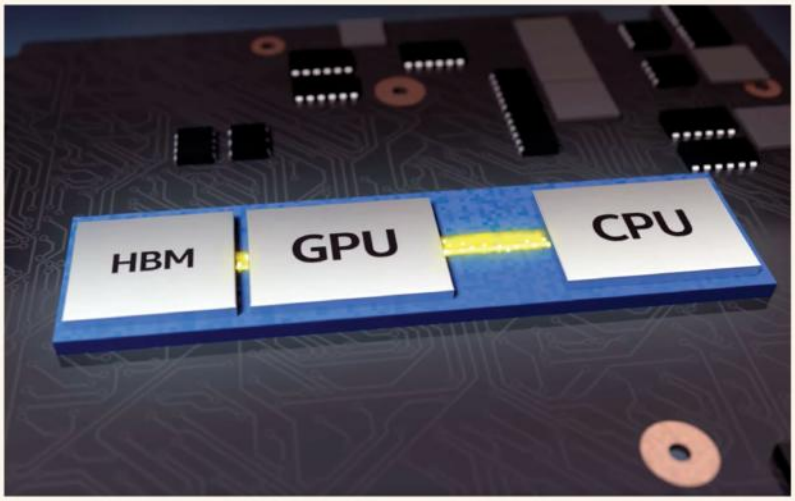
Remember Larrabee, Intel's last grand plan for graphics domination? That was based on a radical new approach to graphics processing. In simple terms, Intel planned to use its chip-production technology advantage to cram scores of small x86 CPU cores into a single chip, and use brute force to render fast 3D graphics. The idea was to launch consumer graphics cards using Larrabee chips in 2010.

That never happened. Turns out, even with the might of Intel's chip fabs behind the idea, Larrabee was simply going to be too slow. Indeed, it's an indication of just how hard it is to break into the high-performance 3D rendering market that even Intel majorly misjudged its entry. So, once bitten, twice shy? Not for Intel. Getting into graphics is simply too important, what with the money in the consumer PC market increasingly moving into relatively high-end performance and gaming rigs, while basic all-purpose PCs continue to be replaced by other general-purpose computing devices, such as tablets and phones.

So, it arguably shouldn't be a surprise that Intel has announced plans to have another crack at discrete PC graphics. This time, Intel is serious. It says it intends to create a full top-to-bottom GPU family, including genuine high-performance graphics for gaming PCs. To do that, it has pulled off something of a corporate coup. Intel has lured AMD's chief graphics guru, Raja Koduri, who joins Intel and goes straight in as senior vice president of the Core and Visual Computing Group, and chief architect of its graphics products.

Currently, the time frames and basic nature of Intel's plans for in-house graphics are unclear. The new AMD Inside processor indicates that Intel knows it will be some time before it can insert its own graphics tech into such a chip, however. That leaves the big question of whether Intel will be using Koduri's brains to come up with something new, or take its existing Gen 9 integrated graphics and scale it into something that can compete with the big boys. It will probably be getting on for five years before we know if Intel's latest play for graphics domination is a goer.

**Forget Larrabee, this time Intel is serious.**




## WHAT IS HBM2 MEMORY?

Putting a CPU and GPU into the same processor package is not a new idea. Intel and AMD have been doing it for years. In fact, they've fused the two into the same slice of silicon, not just put them into a shared package, but as yet, neither has created a CPU-GPU product with genuine high-performance credentials, not from a 3D rendering and gaming perspective at least.

Part of the reason for that comes down to power consumption and thermals. Combining two high-performance components concentrates power consumption and heat dissipation into a very small space. It also makes for very large chips that can be expensive to produce.

But all of that is more a problem that prevents competing at the very highest level. As the latest Xbox One X and Sony PlayStation 4 Pro consoles prove, it is possible to create a single-chip solution capable of high-performance gaming. Instead, as far as the PC is concerned, the problem is memory bandwidth. Thus far, the CPU-GPU fusion chips, or APUs as they are also known, have used a shared memory controller for both parts of the chip. Worse, they've used a standard CPU spec controller with much less raw throughput than the superwide controllers that are used by discrete graphics chips.

That kind of graphics controller, paired with multiple graphics memory chips, isn't viable for a single-package product that also houses the CPU. The solution is High Bandwidth Memory, and, more specifically, the second generation version of the technology, known as HBM2. For starters, HBM2 uses layers of memory stacked on a single chip. That means all 4GB of graphics memory in the new Intel-AMD package is housed within a single HBM2 chip. That happens to be good for overall package size.

HBM2 also has a superwide memory interface at a full 1,024 bits for each memory die. That compares with the dual 64-bit controllers of mainstream CPUs. That superwide interface allows HBM2 memory systems to offer big bandwidth at relatively low frequencies—perfect for keeping a cap on power consumption and heat dissipation. Just one HBM2 memory stack can achieve 256GB/s of raw throughput for the GPU alone. Existing APUs are limited to around 50GB/s, shared with both the CPU and GPU elements.

or declining overall PC market. As basic computing functions become more entrenched with mobile devices, the PC ultimately becomes a power user's tool."

The problem for Intel in that context is that it currently doesn't have a dog in the fight for one of the two key high-performance components in a PC: the graphics. With high-performance PCs increasingly becoming the industry's cash cows, at least in terms of consumer boxes, that isn't something Intel can tolerate. And given it's Nvidia that dominates the graphics half of the market, it's Nvidia that Intel has inevitably set its sights upon. Eventually, Intel will have its own graphics, but for now, the AMD GPU allows it to begin to squeeze Nvidia out of the high-performance consumer graphics market.

If the motivation for Intel is obvious, what about AMD? Surely the last thing AMD wants to do is aid and abet Intel as it plots to assimilate the PC graphics market? Up to a point, that's true. Another competitor to AMD's graphics competence is hardly desirable, but the harsh truth is that AMD needs whatever money it can get. History shows that even when AMD has fairly unambiguously superior graphics products, it struggles to gain market share over Nvidia. AMD has never had the marketing clout or wits to compete with the slick self-promotional machine that is Nvidia.

## HOBSON'S CHOICE?

So, what seems like an unholy alliance with its arch enemy in the CPU market is actually one of the few realistic options AMD has of increasing its market share in consumer graphics. Intel will no doubt drop AMD like a stone the moment it has developed competitive graphics of its own, but in the meantime, the deal brings real money to AMD at the direct expense of its only current rival in graphics, Nvidia.

Further out, a stronger, better financed AMD may well be able to compete with Intel with its own high-performance CPU-GPU package. In Ryzen, AMD finally has a competitive CPU product, and while its Vega graphics architecture has been something

**Intel's tiny NUC system will benefit from the new CPU-GPU technology.**

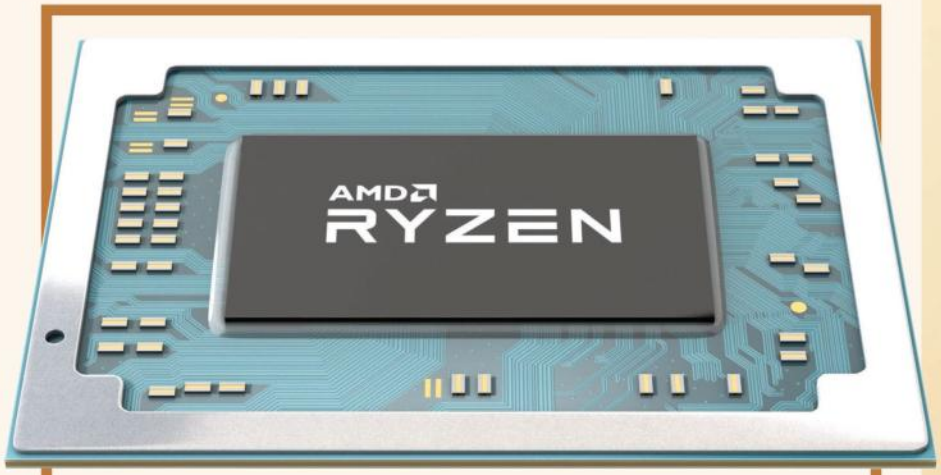
of a disappointment, as part of a CPU-GPU package, it will still be a tough combo for Intel to beat on its own. That AMD has gained experience with the GPU half of creating a high-performance unified package with HBM2 memory, courtesy of the Intel deal, will hardly hurt. In short, AMD is the great survivor, and the deal is expedient. It allows AMD to fight on another day.

For us PC buyers, the impact of this new approach definitely has several upsides. Squeezing true high-performance CPU-GPU tech into smaller, slimmer packages than ever before will allow whole new classes of performance PCs to be created. Thin and light laptops are part of the early sales pitch from Intel, and very welcome they will be, too. We also expect to see the new package pop up in Apple's MacBook products sooner rather than later. Indeed, it's exactly the kind of technology that may enable Apple to apply an extreme makeover to its iMac range, too, and create an all-in-one rig unlike anything we've seen before.

Leaked Intel road maps also reveal a new high-performance Intel NUC system, codenamed Hades Canyon. Due to go on sale at the start of the year, the Hades Canyon NUCs use the new Intel-AMD package, and the high-end SKU is being pitched as VR-capable to boot. Suddenly, Intel has a tiny, living-room-friendly box with genuine gaming capability. It's probably a stretch to say Intel can take on the big beasts of console gaming, but a product like Hades Canyon is a decisive step in that direction.

As for when this technology will roll out on a broader scale, Intel is being fairly cagey, but you can expect to see the first laptops appearing in early 2018. Much will depend on how Intel prices the new package, and how aggressively it incentivizes laptop OEMs, but we reckon Intel wants to do serious damage to Nvidia, so numerous design wins seem likely. If anyone has the clout to supercharge adoption of a new class of processor, it's surely Intel.

**Will Intel deliver on its claims of VR-capable performance?**




## CAN AMD RESPOND?

Intel isn't just sticking an AMD graphics chip into the same package as its CPUs. Intel also now plans to compete directly in the high-performance GPU market with its own in-house designs. The endgame seems pretty clear—namely a unified high-performance solution that combines full CPU and graphics capabilities, and pushes all of Intel's major competitors in the performance PC market to the sidelines.

But hang on: There's another company that has both high-performance x86 CPU and graphics technology. That's AMD, and in fact, it's the only company that currently has both in-house. For Intel, high-performance in-house graphics is merely an aspiration at the moment. If Intel's big new idea with its CPU-GPU package is so clever, surely AMD can simply do its own version long before Intel can catch up on the graphics side?

On paper, that's true. In practice, AMD struggles to sell its products at the high end, even when competitive. AMD could very well produce an outstanding CPU-GPU package and struggle to get OEM PC builders to adopt it. It just doesn't have the marketing clout to fight off Intel's aggressive tactics.

Oh, and if you are wondering, AMD's new CPU-GPU chips, or APUs, codenamed Raven Ridge, are not competitors for the Intel package, with performance AMD graphics and HBM2 memory inside. Currently, Raven Ridge is available in two Ryzen APU models: the Ryzen 7 2700U and Ryzen 5 2500U, both aimed at laptop PCs. Yes, Raven Ridge does combine AMD's fantastic new Ryzen CPU with its latest Vega graphics. In fact, it does so on the same slice of silicon, not just in the same package. But it's that tight integration that reveals the real target for Raven Ridge: Intel's existing laptop processors with integrated graphics. The top Ryzen 7 2700U version of Raven Ridge offers 10 AMD graphics compute units, which works out at 640 unified shaders. That compares with 1,536 shaders in the Intel-AMD product, albeit of a slightly different spec.

Raven Ridge is also a conventional APU in that the GPU part of the chip must share access to memory with the CPU via a standard memory controller. With current PC system memory performance, that pretty much makes it impossible to support high-resolution 3D graphics. CPU memory controllers and DDR4 RAM don't offer nearly enough bandwidth for the GPU alone, let alone when sharing resources with the CPU.

Intel doesn't have a dog in the fight for one of the key high-performance PC components.

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# TECH PORN

PERFORMANCE GEAR LAID BARE

## 1 Clouded The Future Is

We were a little taken aback by the launch of these *Star Wars* themed GPUs. That said, the choice between a light or dark side variant of the world's most powerful consumer card is pretty cool, and both shrouds look exceptional, with bespoke green (Jedi) or red (Empire) lighting.

## 2 Unlimited Power

That aside, there is no difference between the collector's edition and the standard cards. Spec for spec, they're identical, bar a two-degree difference in maximum operating temperature.

# Nvidia Titan Xp Collector's Edition

**WE'VE BEEN GIVEN a total of 160 words to write about this GPU—that's just 160 words to wax lyrical about arguably the most powerful consumer graphics card of the day. Look past the lightsaber styling that adorns the shroud of this barbarous creation, and what you're left with is the full might of the Pascal architecture. It represents the height of what Nvidia is capable of producing today: 12 billion transistors line the heart of this silicon, masterfully crafted to produce no fewer than 3,840 CUDA cores. All firing away and rendering polygons at a rate far greater than any graphics card that has gone before.**

**But we've already seen that. We first met the Titan Xp in April 2017. This is something else, though. A layer of luxury etched into the skin of an indomitable giant. A collector's edition, limited in number, grand in scope, a member of sci-fi royalty, until the next generation becomes master. –ZAK STOREY**

## 3 The Force Is Strong

**4K gaming off a single card is no longer just a pipe dream but a reality. The Titan Xp is no slouch—we've recorded it easily smashing 60 frames a second at 4K. And if the Xp's price is too high? Well, you can always drop your dollar on the GTX 1080 Ti instead.**

Exit

# LINEAGE TO THE RESCUE!

## When Google leaves your smartphone without updates, open source saves the day

**THERE'S A JOKE** that circulates security circles: Android smartphones are really expensive abandoned Linux distributions. It hurts, but it's true. Android is based on the Linux kernel, making Android (more or less) a form of Linux operating system, aka a distribution. Android smartphone manufacturers tend to bash out a device, build whatever the latest version of Android is, support it for the shortest amount of time they can get away with, then abandon the owners—vulnerable to whatever zero-day attack next raises its ugly head—running for the hills, waving their wads of cash.

Take the OnePlus Two. A fine Android phone, but OnePlus dropped support two years after release, just as the Krack vulnerability struck. Tough luck, suckers! This is standard practice in the Android world. But when people are carrying their entire lives around with them on a security-hole-riddled device, perhaps it's time to rethink the situation. So, what can you do?

While you could say a failing of Android—contrasted with Apple iOS—is its easy-to-build-and-forget open-source nature, it means any group can support any devices via the Android Open Source Program (AOSP). And people do. Most famously, there was Cyanogenmod, which blossomed into a huge project, creating builds of Android supporting hundreds of devices, with far more up-to-date releases. But the project closed in December 2016, when the corporate branch that had sprung up shut down the servers that hosted the images, source code, wiki, and so on. That's where its spiritual and source code successor LineageOS rises phoenix-like from the server ashes to power your devices.

**BY NEIL MOHR**

**THAT'S THE POWER** of open source—while one group might shut down development, another is free to pick things up and carry on where they left off. It took a few months through the start of 2017 for servers to be established, web sites to spin up, and development to pick up, but as we start 2018, LineageOS officially supports almost 200 devices, with many more through unofficial development. See the boxout opposite on how to find out what devices are supported, and what to consider when buying a device.

As with Cyanogenmod, LineageOS is built upon the AOSP; the devs take the latest release, which has all the Google software removed, add LineageOS's own additions, create a build for specific devices, and roll out an image update. This means that when a zero-day is announced, such as the critical Krack and Blueborne vulnerabilities, LineageOS developers can roll out an update within days, rather than the weeks, months, or never-ever option big-name Android manufacturers can take, despite having weeks of embargoed warning.

So, who should consider flashing their phone with LineageOS? Probably not your grandmother. We don't like being presumptuous, but it's probably not for her. If your device is still under warranty, wait until it's not. This type of activity voids any cover you might have, and that would be foolish. The process will likely have your phone out of action for at least half a day; if you've never done this type of thing before, more likely a full day—don't forget, there's an element of having to reinstall all your apps, tweak things, curse when something isn't quite right, and start again. It all takes time.

If you've decided that flashing LineageOS on your phone is for you, first make sure your phone is supported; there's not much use carrying on if it's not! Head to https://wiki.lineageos.org/devices, and see whether your device is on the official supported list. If it is, you're golden; if it's not, don't give up hope just yet. Consider this list to be tier-one supported devices; because this is open source, less popular devices can often gain support via the https://forum.xda-developers.com community.

A Google search such as "xda developers <phone model> lineageos" will garner results. Read any returned forum threads to determine how good the support is—hopefully, people will report common bugs or issues. Common issues are the phone, Wi-Fi, Bluetooth, or camera not working—these typically require proprietary binaries to work that may not have been merged into early builds. Other issues include locking up, poor battery life, and other quirks.

The former issues are likely to be deal-breakers, while you might decide you can live with the latter issues. Having used early builds on a number of devices, they usually work relatively well—as long as you have the basic cell phone radio operational. But you need to decide for yourself whether an "alpha" or "beta" build is going to be good enough.

# How Do You Get LineageOS On Your Device?

The general overall process looks like this; we'll go into tools and details shortly

**[Step 1] Back up your device**
*If anything goes wrong, you'll want an escape plan.*

**[Step 2] Get the tools and drivers**

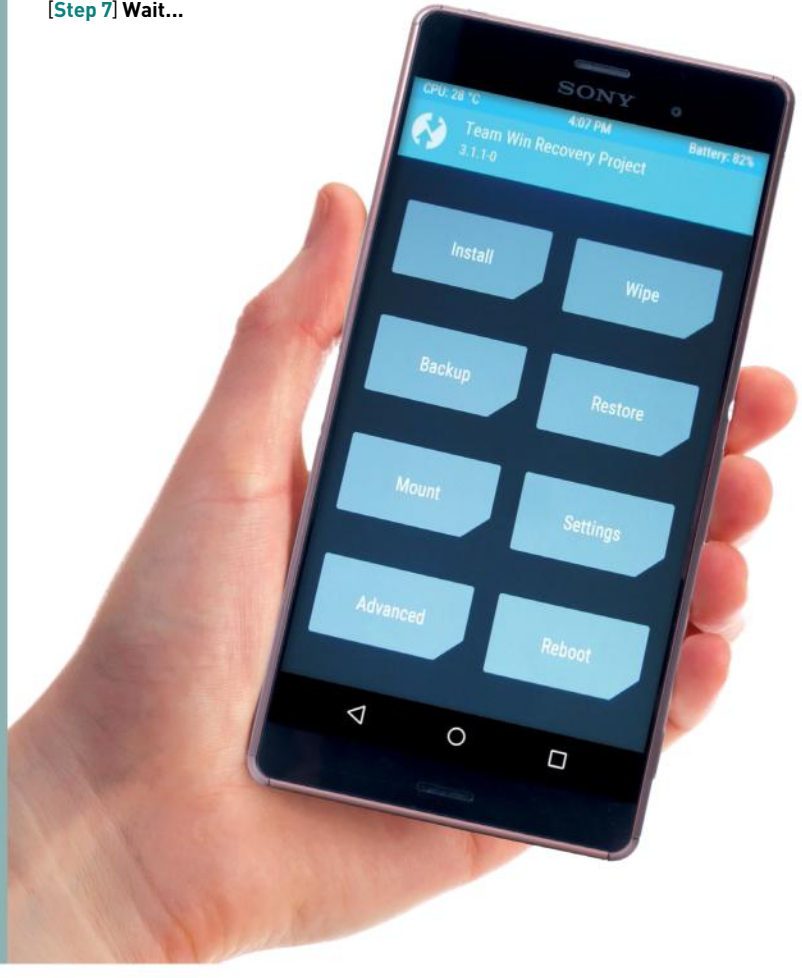
**[Step 3] Unlock your device**
*This wipes everything.*

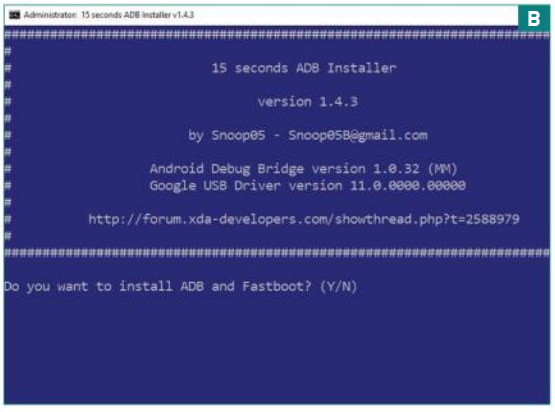
**[Step 4] Install a new recovery ROM**
*Typically, this is TWRP.*

**[Step 5] Copy LineageOS and Gapps to the device**

**[Step 6] Wipe the cache, flash the device, reboot**

**[Step 7] Wait...**

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http://forum.xda-developers.com/showthread.php?t=2588979
Do you want to install ADB and Fastboot? (Y/N)

## 1 BACK UP YOUR DEVICE

If something goes wrong, and you've backed up your device, you can restore it back to its existing state, data, apps, and all.

›› For the lazy, you might just want to back up your data with an app. We recommend My Backup (https://play.google.com/store/apps/details?id=com.rerware.android.MyBackup), which has free and paid versions. If you know how to root your device, Titanium Backup (https://play.google.com/store/apps/details?id=com.keramidas.TitaniumBackup) is more comprehensive.

›› Do you use Two Factor Authentication (TFA) or Google Authenticator? Stop now. You'll lose access and need to re-enable all your TFA-protected services. If you have rooted your device, you can use Titanium Backup [**Image A**] to save off the keys, then restore them afterward. Otherwise, list your TFA-protected services, and either save off the keys or turn TFA off until you're back.

›› For the super-lazy, Google backs up your device to the cloud to a degree; when LineageOS is installed, you'll get the chance to log in to your Google Account and have it restore the apps and settings. Great in principle, a bit hit and miss in practice.

›› Do you want to back up your text messages and call history? Then use a dedicated backup tool. Another good one is SMS Backup & Restore (https://play.google.com/store/apps/details?id=com.riteshsahu.SMSBackupRestore).

›› Full system images are possible, but only via a suitable recovery ROM, such as TWRP (we'll cover this shortly) or ClockworkMod. However, unless you already have one installed, installing one requires the device being wiped in the first place. Thanks Google!

## 2 GET THE TOOLS AND DRIVERS

With a suitable backup done, you're ready to scoop out the brains of your device, and replace them with something altogether better. To perform such a delicate operation, you need the right tools. This tends to be easier on Linux, but we'll use Windows here for simplicity.

›› The two core command-line tools used to monkey with Android devices are Adb (Android Debug Bridge) [**Image B**] and Fastboot. You can download these from Google at https://developer.android.com/studio/releases/platform-tools.html. There's a bunch of other junk in the ZIP that you can safely ignore. Adb is designed to interface and control the Android OS—in other words, Android needs to be running on the device to work. Fastboot is a low-level tool that controls the basic recovery mode access, known as fastboot, on powerup—like your PC's BIOS.

›› The Android ADB driver for Windows is used to recognize the Android device in debug mode, so you need the correct driver. You can get a generic one from https://github.com/koush/support-wiki/wiki/Android-ADB-Drivers. If your device isn't recognized, Google maintains a list of OEM-specific drivers you can try at https://developer.android.com/studio/run/oem-usb.html#Drivers.

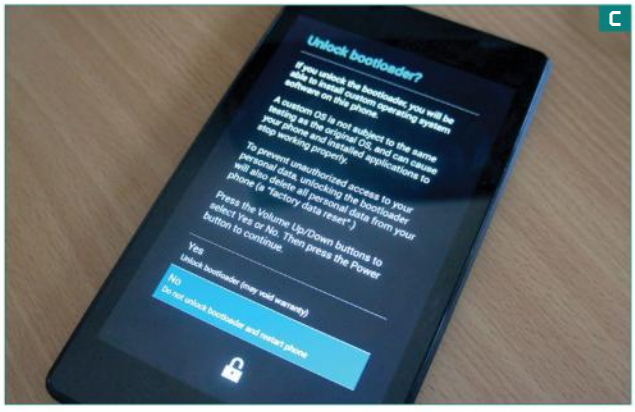
›› XDA developers have created an all-in-one tool and driver installer (https://forum.xda-developers.com/showthread.php?t=2588979). You may want to opt for that to save your sanity!

## DEVICE SUPPORT

We strongly suggest you keep LineageOS support in mind next time you buy an Android device, so once the manufacturer feels it can drop your support like a ton of bricked phones, you have the option of flashing an alternative OS that continues to be supported. LineageOS support tends to go to popular devices. Take a look at the official list at ***https://wiki.lineageos.org/devices*** to get a feel for what is popular: Google devices, Samsung Galaxy S, Note, and Tab ranges, OnePlus, most Motorola Moto devices, LG, the HTC One and Sony Z ranges, among others.

Another consideration is can you flash your device? Almost all manufacturers now offer a (legally required) process to unlock the device, but it varies from one manufacturer to another, and even between devices. Remember, unlocking an Android device wipes everything, and causes a factory reset. You have been warned. A few examples:

- Motorola has a dedicated site with clear instructions, which sends you a device unlock code: ***https://motorola-global-portal.custhelp.com/app/standalone/bootloader/unlock-your-device-a***.
- HTC has its site here: ***www.htcdev.com/register***.
- Sony is here ***https://developer.sonymobile.com/unlockbootloader***.
- Samsung devices are best done via the XDA Odin tool from ***https://odindownload.com/download***.
- OnePlus and Google devices are unlocked via the fastboot command, outlined in the main walkthrough.


C
Unlock bootloader?
If you unlock the bootloader, you will be able to install custom operating system software on this phone.
A custom OS is not subject to the same testing as the original OS, and can cause your phone and installed applications to stop working properly.
To prevent unauthorized access to your personal data, unlocking the bootloader will also delete all personal data from your phone (a "factory data reset").
Press the Volume Up/Down buttons to select Yes or No. Then press the Power button to continue.
Yes
Unlock bootloader (may void warranty)
No
Do not unlock bootloader and restart phone

## 3 UNLOCK YOUR DEVICE

Now we're all primed, the first major step is to unlock your device. This wipes everything, resetting the device back to factory defaults. You have been warned. Annoyingly, it seems that every manufacturer provides a different unlock mechanism—see the "Device Support" boxout on the previous page for more details. We're going to follow the default Android system that is used by Google and OnePlus.

» To begin, we need to activate Developer mode, and switch on USB Debugging. In Android, select "Settings → About," and tap the build number seven times. A message announces that Developer mode is unlocked. Select "Settings → Developer option switch on USB debugging." If there's a OEM unlocking option available, select that as well.

» Once USB debugging is on, you've installed the ADB drivers, and unzipped the tools, connect your Android device. A security message appears on the Android device—allow the connection.

» Select "Windows," type "CMD," and press Return. "CD" to where the tools were extracted. For simplicity, you can copy Adb and Fastboot to your desktop, and just work with "CD desktop." To reboot into recovery, type "adb reboot bootloader." To unlock, type "fastboot oem unlock." A warning appears [**ImageC**]—read this, and accept the responsibility, or run screaming into the hills.

## 4 INSTALL A NEW RECOVERY ROM

You'll want to reboot your Android device and log in—don't worry about accounts, this is just so we can copy over recovery images, LineageOS, and so on. At this point, we're concentrating on adding a custom recovery ROM. This is accessible when a device is first powered up via a key combination, such as Power and Volume Up or Down. You can also reboot into it via the Adb tool. Using the custom recovery ROM, we're then able to flash a new OS and do complete system backups.

» The most commonly used recovery ROM is TWRP (Team Win Recovery Project), so head to https://twrp.me/Devices, and download the correct ROM for your device. If one isn't listed, you should try searching for a Clockworkmod recovery image for your device. Copy the recovery image into the same folder as the Fastboot command.

» If you know how to reboot into fastboot recovery, do so. Otherwise, put the device back into USB Debugging mode, as explained in the previous step, and in a command prompt, type "adb reboot bootloader." To flash the recovery image, type "fastboot flash recovery <image file name>." Select to start recovery, and enter TWRP. At this point, you can boot back into "System," aka Android [**Image D**].

## MIND THE GAPPS

We've mentioned that AOSP can't include proprietary Google code; the ramifications of that is that a default install of LineageOS doesn't offer Google Play services or any associated Google Android apps you might be familiar with, such as Maps, Keep, Hangouts (oh no–Ed), Gmail, and so on. You do get open-source equivalents of some, such as Calendar and Contacts, but it's not the same if you're switching, and you're going to want access to the Google Play Store.

That gaping gap is filled by the Open Gapps project at ***http://opengapps.org***. This provides a suite of downloads, from a minimal 125MB Pico install that's the base Google Play services, to a full-fat Super package at 860MB, which includes every app ever shipped to a Google device.

You need to choose the correct platform. ARM is 32-bit (similar to x86), which is most devices out there. ARM64 is for 64-bit devices. These devices and newer are 64-bit: OnePlus Two, Samsung S6/Note 8, Google Nexus 5X/6P, Pixel 1/2. If it offers 4GB of memory, it's likely 64-bit. If it's an Intel Atom, you need the x86 build.

Choose the correct Android version for the release of LineageOS you're installing—probably Android 7.1—then the variant. We recommend Nano, because you can install just the Google apps you'd like once you're up and running. Avoid Stock, unless you're running a Google device, as the camera app (designed for the Pixel) can go a bit screwy. If you want everything, choose Super or Full.

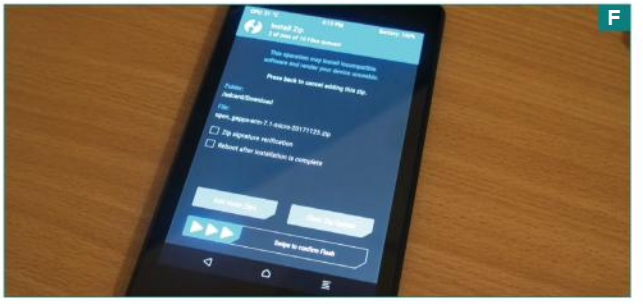
We recommend you copy and install this alongside the OS image—you can stack up packages to install via TWRP. If you encounter any odd crashes after LineageOS starts, reboot to TWRP Recovery, and clear the ART Cache and Cache to clear this up.

***You want Google Play and its privacy snooping services, right? You need to grab the Gapps package, then.***

E

## 5 COPY LINEAGEOS AND GAPPS TO THE DEVICE

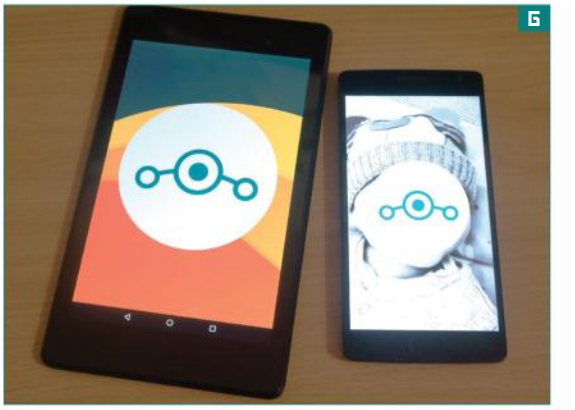
As discussed, download the LineageOS build (https://wiki.lineageos.org/devices) for your device. Currently (early 2018), we recommend v14.1, which aligns to Android 7.1. Android 8 Oreo is v15, and is likely somewhat experimental at this stage, but read the logs and any forums reports to make up your own mind. At this stage, you can also grab your faux Google Gapps package [**Image E**] from http://opengapps.org—see the boxout below-left for more details on that. Copy both ZIPs to the device—into the "Download" folder, say—and no, you don't need to unzip them.



F

## 6 WIPE CACHE, FLASH DEVICE, REBOOT

Reboot into TWRP Recovery. Type "adb reboot recovery" if you have a command prompt to hand, or power down, and use the Power and Volume combo. Wipe the Data, Cache, and Dalvik/ART Cache (this is the default), tap "Wipe," and swipe to go. Not doing this can cause the install to return an error. Return to the main menu and choose "Install." Select "Download" and the LineageOS ZIP. Choose "Add More Zips," and do the same for Gapps [**Image F**]. Swipe to flash, and kiss goodbye to old Android. Once done, do a default wipe again, then reboot into Android. The first boot can take five minutes or so.



G

## 7 ENJOY YOUR NEW OS!

Welcome to LineageOS [**Image G**]. If you want to use the cloud restore linked to your Google Account, there's an odd quirk at the time of writing. To log on to a wireless network, you need to first choose to not restore from another device/the cloud, set up a wireless connection, then step back, and restore. Otherwise it doesn't set up a connection, making it tricky to download from the cloud.

» Once LineageOS is working, you'll have access to the Google Play Store. If your Google Account is up and running, apps are slowly restored with some settings in place. Check Security settings, tweak the Notification drawer, and perhaps get a new launcher; Nova Launcher is our favorite.

» We've mentioned "root" access—this is administrator level access to the Android system. It's generally not required, and considered a security risk, which is why it's off by default, and hard to turn on. If you want root access for backup reasons, Lineage OS makes it reasonably easy.

» Grab the Super User pack for your device's architecture from https://download.lineageos.org/extras. Copy it to your LineageOS device, reboot into TWRP, and flash the su.zip. Back in LineageOS, enable Developer mode, if you haven't already. You'll see an option called "Root access"—select "Apps and ADB mode." Now apps can be given root access.

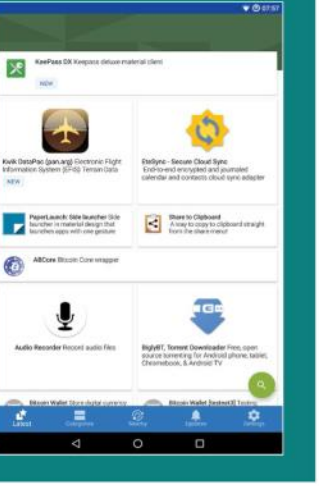
Depending on your device, you could find you're getting LineageOS updates once a week. Don't feel you need to install them. You can follow the recent changes update log for your device at https://download.lineageos.org, along with any changes that will be merged into the next build.

# THE OPEN-SOURCE WAY

Proprietary software is pure evil, so some people say. It denies you ownership of something you've paid money for, hides the true nature of the software, and enables spying, backdoors, and security holes to propagate without the user's knowledge. While some of that is still possible with open source, the chances of it happening are much reduced. To try to bring open source to Android, a system was created called F-Droid, available from ***https://f-droid.org.***

You can install this on standard Android and LineageOS, as long as you enable "Unknown Source" within the Security settings. Then download and install the APK from the website. F-Droid attempts to be an open-source repository, offering freed software to anyone willing to install it. The quality and range of open-source software available has come on a long way in recent years, and if you're looking for a system tool, or something a little more creative, it's a good place to stop and look for software that at least respects your rights as a user. We're not expecting you to dump the Google Play Store, but F-Droid offers an alternative source of Android software that you can trust.

***A world of freed software is an install away with F-Droid.***



# MAKE YOUR OWN PROJECTS WITH THE RASPBERRY PI

Learn the electronics, computing and coding skills you need to make your own projects with the Raspberry Pi, and let your imagination run wild

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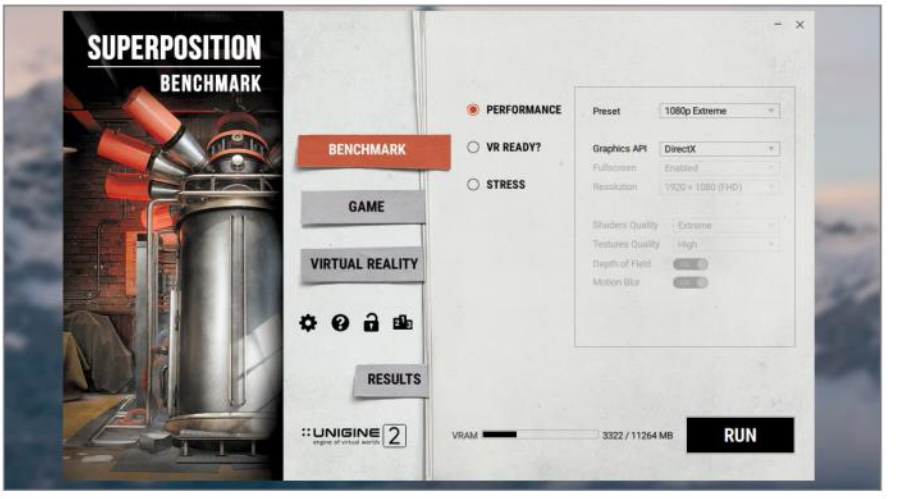
# HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

## TIP OF THE MONTH




### QUANTUM BENCHMARKING

We've been toying with new benchmarks for a while, and at the top of the list of potentials for systems and GPUs is Unigine's Superposition benchmark. One of the most demanding applications we've seen so far, it features VR-ready tests, stress tests, and a whole suite of benchmarks, including custom runs, all the way up to 8K. Talk about future-proof! Best of all, it's free. https://benchmark.unigine.com/superposition

ZAK STOREY
DEPUTY EDITOR

## INVESTING TODAY

It's a difficult time to be someone of my generation. We regularly get a bad rap, and it's often for our lack of commitment to values that were achieved earlier in life by the previous generation. But it's not for a lack of want—there's nothing I'd like more than to have a place to truly call my own. However, securing the down payment for your own slice of real estate is increasingly challenging for people hoping to get a foot on the property ladder.

This probably won't surprise the majority of you, but technology journalism doesn't pay all that well. So, being strategic about how and where we invest our savings and bonuses is paramount.

But invest in what, exactly? Well, the most obvious one for any budding techie is Bitcoin. The boat may have long sailed on the mining front, but there are still two major ways in which you can acquire the legendary cryptocurrency. Firstly, there's NiceHash. It's an easy-to-use piece of software that trades your hardware's mining capability and electricity in exchange for payment in Bitcoin. The second solution? Buy some Bitcoin. After all, last year we saw Bitcoin increase in value from $1,000 all the way up to $19,500, and barely even flinch. A bubble? Perhaps, but some predict it could reach all the way up to $100K and beyond in the next 10 years.

## MAKE – USE – CREATE

**54**
Send secure and private messages with RetroShrare

**58**
How to unlock and overclock Intel's non-K CPUs

**70**
Building a sub-$2,000 monochromatic PC—in black and white

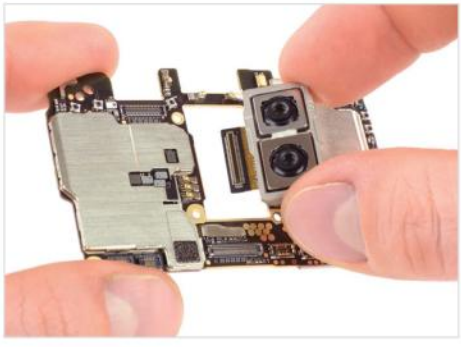
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

# AUTOPSY

THIS MONTH WE DISSECT...

**The Mate 10 Pro touts an impressive 20MP and 12MP lens setup on the rear, to better differentiate depth of field.**



**4,000mAh for a day's use in less than 20 minutes of charge time? Sounds too good to be true—unfortunately, there's no wireless charging here.**

# Huawei Mate 10 Pro

## BACKGROUND

We've been waiting patiently at the end of the dock for the Mate 10 Pro to sail in from its Chinese smartphone maker. And we haven't stood in the cold for nothing—after a warm welcome, this new smartphone is going straight to the teardown table.

## MAJOR TECH SPECS

- Octa-core Kirin 970 and Mali-G72 MP12 GPU
- 6.0-inch 1080x2160 (402 ppi) AMOLED display
- Dual 20MP and 12MP f/1.6 main camera unit by Leica
- 8MP f/2.0 selfie camera
- 128GB storage and 6GB RAM, or 64GB storage and 4GB RAM
- Android 8.0 Oreo and EMUI 8.0

## KEY FINDINGS

- Before we deconstruct the Mate 10 Pro, we line it up next to one of its predecessors, the Mate 9, for a quick comparison. At first glance, differences are minor: there's the new Leica dual camera with optical image stabilization, and the round fingerprint sensor below. More noticeable is the ergonomic curved glass back and a signature stripe highlighting the dual-lens camera. You may notice that the Mate 10 Pro is slightly smaller than the Mate 9—although the display is 0.1 inches bigger. The new 6.0-inch display is nearly bezel-less.
- In the absence of twistable fasteners, we drop an iOpener and start heating the back of the phablet. Given that IP67 rating, perhaps we should expect trouble. Surprisingly, the heated adhesive doesn't stick too well to the back cover, and with the use of some Opening Picks, we separate it from the main body. Like the Mate 9, the 10 Pro's fingerprint flex cable still tethers the back cover to the rest of it.
- The Mate 10 Pro's valuables are well protected, and covered with a large metal shield. We remove one of the many liquid indicators and all the Phillips screws we can find, as well as a small metal shield covering the fingerprint sensor flex connection. The screws seem to be some kind of aluminum alloy—they don't attract much to any of our driver bits, nor to the magnetic mat. With everything unscrewed, we rub our hands in anticipation of what we'll find. Next to come out: the large shield holding the dual-LED flash, which protects all flex connections and contacts on the motherboard.
- We're excited to cleave our way to the motherboard, but first we spot something worthy of a detour: the battery! A big slab of adhesive spans nearly the entire bottom of the battery. With some heat and help from an iFixit Plastic Card, we can extract this 4,000mAh beast. With its 3.82V and up to 15.3Wh of power, it's the same as in the Mate 9. It's coupled with smart battery management that learns from user behavior to minimize wasted power and maximize battery life. Huawei promises a full day of use with just a 20-minute charge.
- Repairability Score: 4 out of 10 (10 is easiest to repair). Despite the IP67 seals, the back cover is simple to open. The USB port, loudspeaker, and mobo are easy to remove. The Mate 10 Pro has very few screws, all standard Phillips, but unimpressed by magnetism—except one, buried beneath the display. With only one big cable, the Mate 10 Pro is cleanly arranged—though that cable is soldered to the USB port. A damaged front camera means switching the whole display, including the frame, or damaging the display while trying to remove it. And replacing the display—the most common repair—means taking out almost every component.

### About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

# Secure Messaging with Retroshare

## YOU'LL NEED THIS

**RETROSHARE**
Download this free, open-source software from www.retroshare.net.

**A FRIEND**
You need at least one similarly privacy or security conscious friend.

**THESE DAYS,** our privacy and security are constantly under attack, not just from foreign agencies or hackers, but even big business and government. If you're looking for a way to keep your online communications private, Retroshare is one of the most secure options out there.

Retroshare describes itself as "a secure decentralized communication platform." In layman's terms, this means there are no central servers where sensitive information is stored; instead, Retroshare employs a variant of P2P technology it calls Friend-to-Friend (F2F). F2F enables you to build a private network of friends without anyone else—including your friends—knowing who's in it.

Whatever your messaging needs, Retroshare has your back covered. Within a single application, you'll find tools for instant messaging, private mail, secure P2P file sharing, and public and private chat channels. While the program isn't completely anonymous—your identity enables your friends to see both who you are and what your IP address is—there are tools and channels you can access completely anonymously.

Perhaps Retroshare's biggest fault is in trying to cram so much functionality into a single tool, which creates a cluttered and fussy interface, with useful settings buried away. But if that's been putting you off, fret no more. We've dived in headfirst with the help of some friends to navigate its murky waters, and show you how to get started with your own private network. –**NICK PEERS**

### 1 SET UP PROFILE AND FIRST NODE

Head to www.retroshare.net and download the latest Qt4 version, because it's the same user interface found in the Mac and Ubuntu versions. Once downloaded, double-click the setup file and follow the prompts—you have the option of installing it as a regular application, or as a portable app.

›› Launch Retroshare, and create a new username and password [**Image A**]—the stronger the better. Keep moving your mouse randomly around the screen until the progress bar is at least 20 percent (but aim to reach 100 percent). Once you're happy, click "Generate new profile and node."

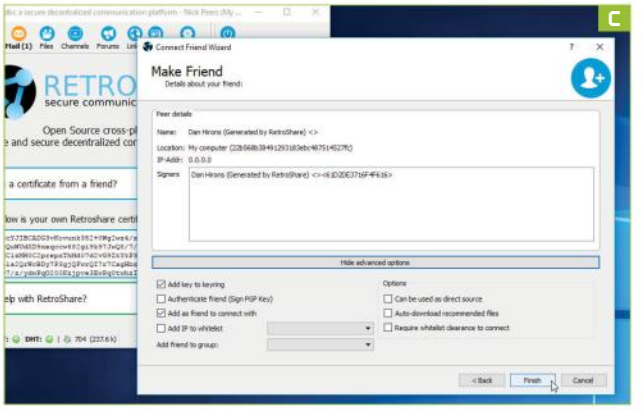
### 2 SWAP CERTIFICATES WITH A FRIEND

Close the welcome screen to view your Retroshare certificate—a lengthy string of alphanumeric characters and symbols. Click the Retroshare icon above it to reveal five different ways to make friends [**Image B**]. We're assuming you're following this tutorial with a friend, so choose one of the two ways to share your certificate: either via the clipboard (which you paste into another document or application), or a file. If you choose the "Save your Cert into a file" option, save it with a *.rsc file extension, then transfer it securely to your friend—either physically (via USB flash drives, say, or even a printout), over a local network share, or perhaps via another secure messaging platform, such as PGP-encrypted email.

### 3 MAKE CONNECTION

Once you've received it, click "Add friends certificate." You can type it in painstakingly by hand, paste it from your clipboard, or click "Open certificate" to open the certificate file they've shared with you. Click "Next," and you'll see it's signed by the name of the person it purports to be from. If you're not 100 percent convinced of the origin of the file, click "Finish." But if you're happy with its veracity, click "Show Advanced options," and check "Authenticate friend (Sign PGP Key)" [**Image C**]. This adds your proof to the key that it's genuine, to help others decide whether it's safe or not. If you've decided to authenticate the key, you need to enter the password you created in step one after clicking "Finish."

B
RETROSHARE
secure communication for everyone
Open Source cross-platform,
private and secure decentralized communication platform.
Did you receive a certificate from a friend?
Add friends certificate
The text below is your own Retroshare certificate. Send it to your friends
Copy your Cert to Clipboard
Save your Cert into a File
Send via Email
Invite via WebMail
Recommend friends to each others
Do you need help with RetroShare?
Open Web H




## 4 COMPLETE CONNECTION

A Connection Assistant opens, which sets up your network connection. When it's online, it confirms you've reached your friend. You may need to prod your friend via their "Log" button to accept. When done, you'll see a "Congratulations, you are connected" message. Click "OK," then switch to the "Network" section, where they're listed under "Friend Nodes." Repeat for any other friends.

» Go to the "Network" section and switch to the "Network graph" tab. You'll see how you're connected to your friends, but that they're not (yet) connected to each other. This serves as a reminder of how Retroshare's F2F network works: All connections are individual; you don't simply gain access to another person's set of friends.

## 5 LINK FRIENDS TOGETHER

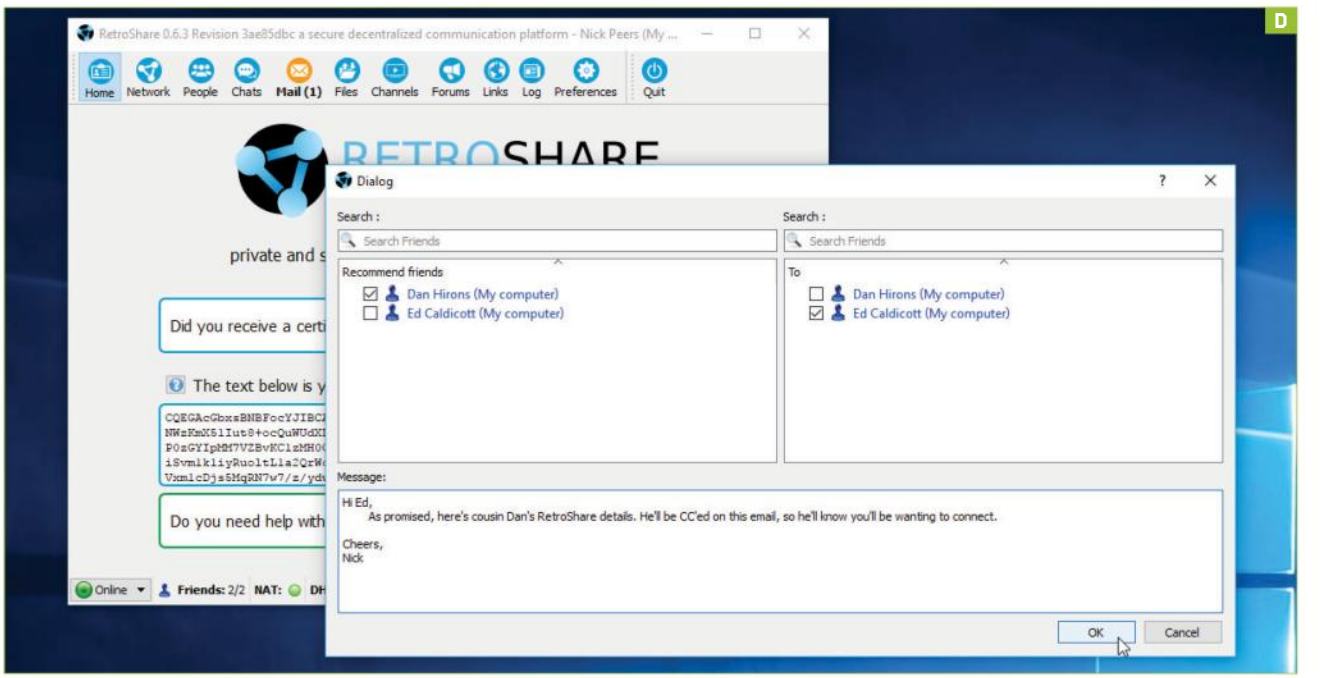
Friends can—if they wish—connect directly, too. This is done via the "Add" button from the "Home" section. This time, choose "Recommend my friends to each other." You need to check the boxes of those you wish to introduce in both "Recommend friends" and "To" [**Image D**]. Your friends then receive two messages in their Mail box, one directed to them, and the other where they've been CCed. They need to open the message directly addressed to them, where they'll see the other person's Retroshare certificate has been attached: Just click this to add it in the usual way.

# WORKING WITH NODES

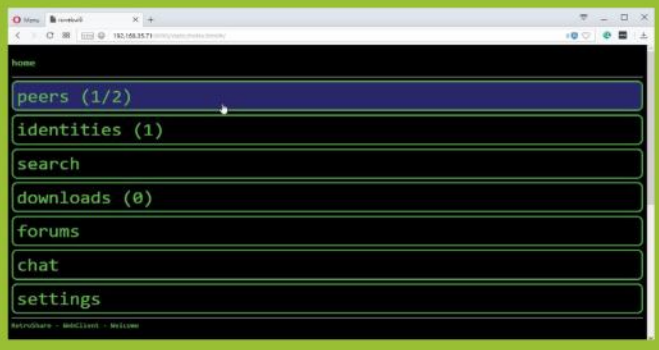
To use Retroshare on more than one computer, you need to transfer your profile. First, export it from your PC: Select "Network → Keyring," right-click your profile entry, and choose "Export/create a new node," then "Export selected key." Save the .asc file and transfer it to your new computer.

Open Retroshare on the second device, and click "Option → Advanced options," then "Option → Use existing profile." Load in your .asc file. This pre-fills the profile name—give your node a name to differentiate it from your main PC, then enter your password, move the mouse about, and click "Go!"

By default, each node shares your name, PGP ID, and PGP fingerprint, but they're assigned unique location IDs. Each node is—by default—isolated from the others, so you can choose who gets to contact you on each node. The quickest way to copy all your friends across is via the "Network" section. Right-click "Trusted nodes" (or a group name), and choose "Export friendlist." Transfer the exported file across, then re-import it into your new node from the same dialog.



## TIPS AND TRICKS




As if Retroshare's existing features weren't enough, it's possible to expand it further using plugins. Two are included with the Windows version, but are disabled by default. Navigate to "Preferences → Plugins," and click "Enable" next to the VoIP.dll plugin to add voice and video chat to Retroshare's "Network" button; enable FeedReader to set up an RSS feed for your own use or to share via a forum. Once enabled, configure both via their own sections in "Preferences" (in the case of the VoIP plugin, both you and your chat partner need it installed and running to use it).

Retroshare comes with a built-in web interface, giving you access to a limited subset of its features through your web browser. Navigate to "Preferences → Webinterface" to enable it. By default, you're limited to access through the computer Retroshare is installed on; check "Allow access from all IP addresses," and you can then access it from other computers on your local network using their IP address, and the designated port—for example, 192.168.0.3:9090.

### 6 REVIEW CONNECTIONS

Once your friends are connected to each other, switch to the "Keyring" tab under "Network" to review all the keys you've received—look at the Trust level. "Personal signature" refers to the fact you received the certificate directly from them, while "Untrusted peer" indicates you connected through a third-party introduction.

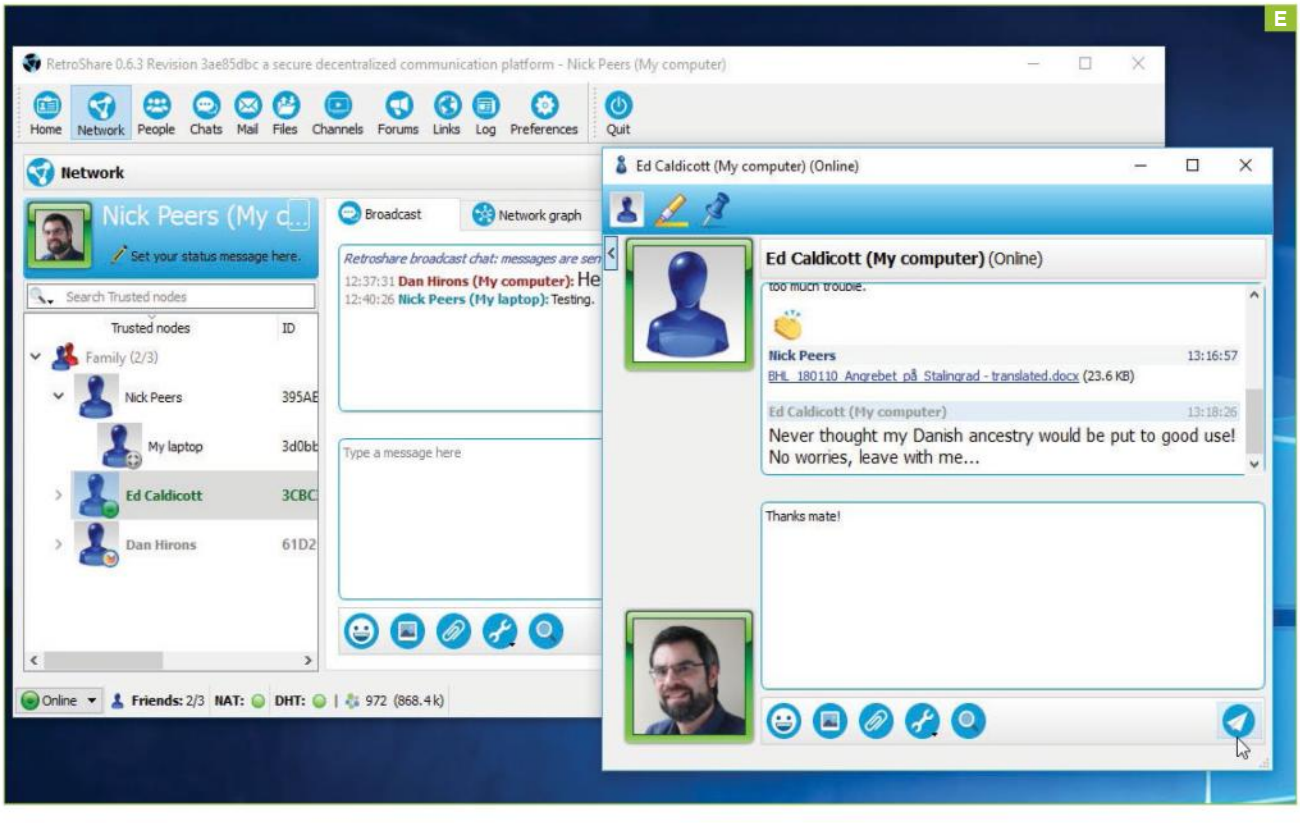
» If you're confident the person is who they appear to be, right-click their profile, and choose "Profile details." You'll see a list of people who have signed the key, plus a "Trust level" drop-down menu—click this to indicate your confidence in this person. If you trust them implicitly, click "Sign this key" if you haven't already done so—when you then introduce them to other people, they'll see that you've signed their certificate, too, indicating they're genuine.

### 7 USE RETROSHARE FOR CHAT AND MESSAGING

The "Network" tab doubles up as Retroshare's instant messaging client. Double-click a person in the left-hand window to open a message window, then use the tools to chat with them. It works in a similar way to Skype and other IM tools: chat, add smileys, swap photos and files, and so on. You can search your chat history, plus save, clear, or delete it [**Image E**]. You can also send a message to everyone currently online in your nodes list using the "Broadcast" tab. Type a message, and it appears in the "Broadcast" tab.

» Right-click a person's name, and you'll see various options, including one for organizing them into groups. Several presets—co-workers, family, favorites, and so on—are provided, or you can create your own. This option enables you to name your group, plus quickly file people into it. You'll then see people filed accordingly in the list.

» Switch to the "Mail" section, and you'll see that Retroshare can also be used as a private email service



between you and your contacts. It works in much the same way as regular email, with messages held until you're both online and logged into Retroshare, at which point they're delivered.

## 8 SHARE FILES SECURELY

Another use for Retroshare is as a P2P file-sharing tool. Switch to the "Files" section. Click "Configure shared directories" to edit the default directory (where files you download from others appear), and add more. Click "Add new" to select (or create) your new shared directory. Double-click "[Unset]" under "Visible name" to give it a name that others will see when browsing the "Friends files" tab of their "Files" section.

›› The default settings for file searching (no anonymous searches) and downloading (using anonymous tunnels) are best left alone. Note that content isn't visible to your contacts unless you double-click the green button. By default, all can now view it, so right-click "[All friend nodes]," and choose "Change group visibility" to make it visible only to a subset of your contacts using the groups from the previous step. You can set up multiple shared folders with different access controls for each—click "Apply and close" when done.

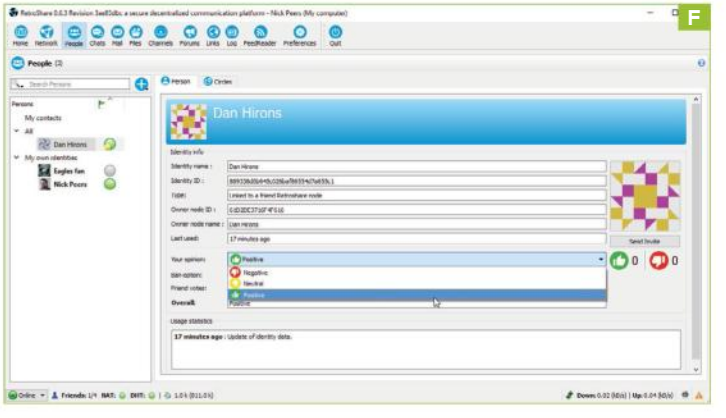
›› Now simply copy files into this folder and other users can download them via the "Friends files" tab. Use the "My files" tab to review what you're sharing; expand the shared directory name to view the contents of the directory. It can take a little while for new files to appear—click "Check files" to force a refresh of the view. You can also group files into "collections"—this is a simple file you can distribute to others. When they click on the collection, the files listed in it are automatically downloaded into the same folder structure you've set up inside the collection.

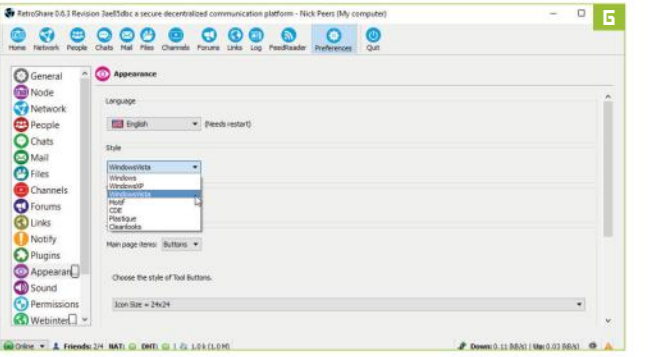
›› If you encounter sluggish Internet speeds because too many people are grabbing your files, go to "Preferences → Network" to set a universal bandwidth limit for uploading files, or right-click a contact and choose "Profile details → Options tab" to set restrictions at an individual level. Keep an eye on the "Down" and "Up" levels in the bottom right-hand corner of the main Retroshare window to see what's going on.

## 9 BUILD IDENTITIES

Switch to the "People" section, where you create profiles to identify yourself in other parts of Retroshare. Use the "Person" tab to view your own identity as it's seen by others you're connected to. Right-click it and choose "Edit identity" to modify it—change your nickname and set your avatar or photo.

›› You can also create new identities that sit alongside your existing ones—to do so, click the "+" button next to the "Search Persons" box, and choose "Create new Identity." By default, the identity is "owned" by you, so while you provide a nickname and avatar, your profile details are also available for others to see. You can also create completely anonymous "pseudonyms"—provide a nickname and an avatar, but relax in the knowledge there's nothing to link them back to your own profile.




## 10 ADD TO CIRCLES

By default, other people's identities don't appear under "People." You can rectify this by way of the Circles feature. First, click "+" and choose "Create new circle." Give your circle a suitable name, and leave it set to "Public"—this ensures your contacts (but no one else) will be able to see you and your new circle in their "People" section. Select an identity linked to your profile in the right-hand pane, and click "<" to add it to the list of invitees, then click "Create."

›› Now switch to the "Circles" tab, and expand "Other circles." Expand your circle, right-click your name, and choose "Accept this invitation" to join the circle. It now moves to the "Circles I belong to" section, and both the circle and your contacts will now be able to see your identity. They can now right-click the circle and choose "Request subscription." If you accept their request via the "Circles "tab (when their name appears, right-click, and choose "Grant membership"), they'll show up in your "People" list, too [**Image F**].

## 11 AND THERE'S MORE

Set up private chat rooms via the "Chats" button—click "+" to set one up. You can choose an identity to use, whether it's public (all your friends) or private (invitation-only), and ban pseudonyms (check "Required PGP-signed identities"). Chat rooms work much like the one-to-one instant messaging tool, only for larger groups.

›› Retroshare also offers Channels—a mechanism for spreading data around your network. The channel's creator is the only person who can post to the channel, but others can download your content, and you can enable comments, too. Note that public channels go beyond your friend network—stick to circles or node groups to limit who has access.

›› Forums work in the same way as regular Internet forums, except everything is, of course, encrypted and decentralized. Links are another variation on the same theme. In short, we've barely scratched the surface of what Retroshare can do. It's incredibly flexible, with each section packed full of hidden tips and tricks—click "Preferences," and work through the sections to discover even more tweaks and settings to apply [**Image G**]. Head over to https://retroshare.readthedocs.io/en/latest/user-guide/interface and work your way through the various sections, where you'll gain advanced insights into features we've covered, plus learn about the other sharing tools that we've only touched upon.

# Overclock Intel's Non-K CPUs

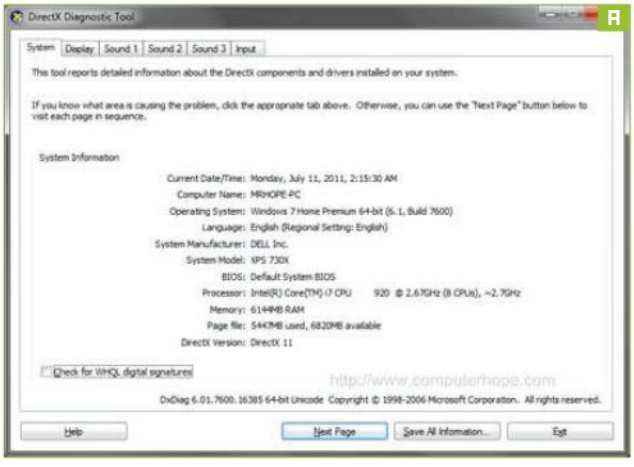
### YOU'LL NEED THIS

**Z170A MOTHERBOARD**
Sadly, non-K overclocking is only available on this particular chipset.

**AN OLD BIOS FILE**
New Z170A boards ship with the overclock hack patched out, but the old files still exist at https://overclocking.guide/intel-skylake-non-k-overclocking-bios-list.

**ONCE UPON A TIME,** Asrock did something wonderful for owners of Intel's non-K Skylake CPUs. For years previously, the benefit of buying a pricier K chip was that it was fully unlocked for overclocking, but in 2016, the rulebook was ripped up when a particular feature in Asrock's Z170A boards allowed base clock multiplier tweaking on those erstwhile locked K CPUs. Before long, MSI, Asus, Gigabyte, and the whole gang were offering the same BIOS feature, which disabled integrated graphics and turbo boosting in order to enable overclocking. Intel was understandably less than pleased about this—the company's entire product hierarchy was suddenly jumbled up like a fallen Jenga tower—and just a couple of months later, overclocking features disappeared from Z170A boards.

In terms of outward appearances, the story pretty much ended there. Non-K chips returned to their previous station as staunchly locked cheaper chips, and the tech universe's natural order was restored. But those old BIOS files still exist, and are still available to download, so if you're currently running a non-K Skylake chip on a Z170A board, you can absolutely still make use of that old feature, and produce a significant performance boost for absolutely zero outlay and minimal time investment. Here's how. **–PHIL IWANIUK**


A
DirectX Diagnostic Tool
System
Display
Sound 1
Sound 2
Sound 3
Input
This tool reports detailed information about the DirectX components and drivers installed on your system.
If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.
System Information
Current Date/Time: Monday, July 11, 2011, 2:15:30 AM
Computer Name: MRHOPE-PC
Operating System: Windows 7 Home Premium 64-bit (6.1, Build 7600)
Language: English (Regional Setting: English)
System Manufacturer: DELL Inc.
System Model: XPS 730X
BIOS: Default System BIOS
Processor: Intel(R) Core(TM) i7 CPU 920 @ 2.67GHz (8 CPUs), ~2.7GHz
Memory: 6144MB RAM
Page file: 5447MB used, 6820MB available
DirectX Version: DirectX 11
Check for WHQL digital signatures
http://www.computerhope.com
DxDiag 6.01.7600.16385 64-bit Unicode Copyright © 1998-2006 Microsoft Corporation. All rights reserved.
Help
Next Page
Save All Information...
Exit

## 1 CHECK YOUR SYSTEM'S COMPATIBILITY

The first order of business is to figure out whether your CPU and motherboard can hack this, er, hack. Essentially, the full gamut of non-K Skylake CPUs are fair game for this, starting at the entry level with the Pentium G4400, and extending right the way up to the Core i7-6700. T chips are compatible, too. It's worth bearing in mind that the overclocking potential of a $50 Pentium CPU is going to be much lower than a Core i7, and this BIOS hack isn't going to turn one into the other. It's free additional performance whatever the chip, though [Image A].

›› As for motherboards, check this handy web page for a full list of the Asus, Asrock, MSI, and Gigabyte boards: https://overclocking.guide/intel-skylake-non-k-overclocking-bios-list. If it's a Z170A motherboard, it's extremely likely that you have the hardware to pull this off.

## 2 FIND THE OLD FILE

In order to enable overclocking, you need to flash your motherboard to an older BIOS that predates Intel clamping down on the practice. Doing so has pros and cons: Older firmware might produce hardware conflicts or cause any problems your motherboard model had at launch to re-emerge, because you're

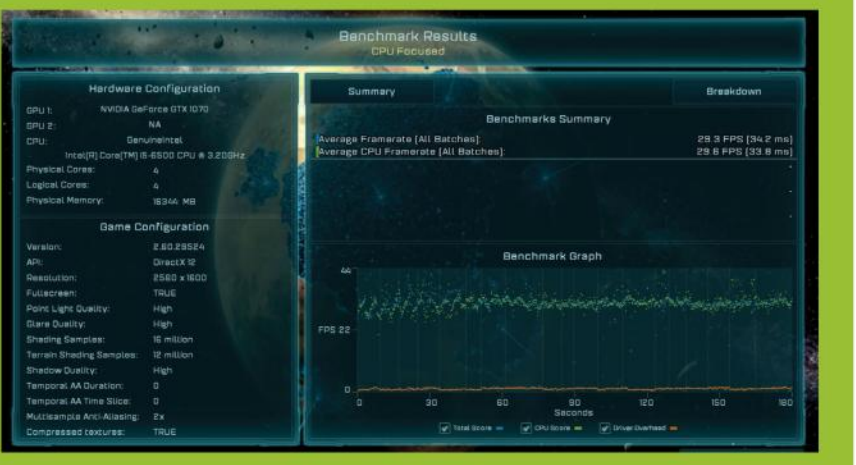
effectively rolling back all manufacturer support to late 2016. In our experience, though, this is unlikely. If the worst comes to the worst, and you have a USB port that Windows keeps discovering and forgetting every 10 seconds after flashing your BIOS, you can always install the newer version again to remove the issue. To start the ball rolling, head to the site we've linked to in step one. You'll see a list of motherboards, each with a BIOS file to download. Simply locate your own motherboard model and download the BIOS file [Image B].

## 3 FLASH YOUR MOBO'S BIOS

There was a time when flashing your BIOS was a scary process. One power outage or erroneously

# OFF THE CLOCK

How much extra performance can you squeeze out of a non-K chip? We'll use a Core i5-6500, and run some benchmarks to demonstrate. It's overclocked by 1.1GHz, from 3.2GHz to 4.3GHz, while the RAM is at just over 3,200MHz. First up is Heaven 4.0, a GPU-intensive app that doesn't show much improvement for that extra 1.1GHz: 50.2fps at stock speeds, and 50.3fps overclocked. Heartbreaking. Things get more encouraging when running CPU-intensive RTS A*shes of the Singularity: Escalation,* though: 25.8fps at stock, 29.3fps overclocked. Cinebench R15 sees a jump from 524 to 727, while *Middle-Earth: Shadow of War* jumps from 52fps to 62fps. Result!



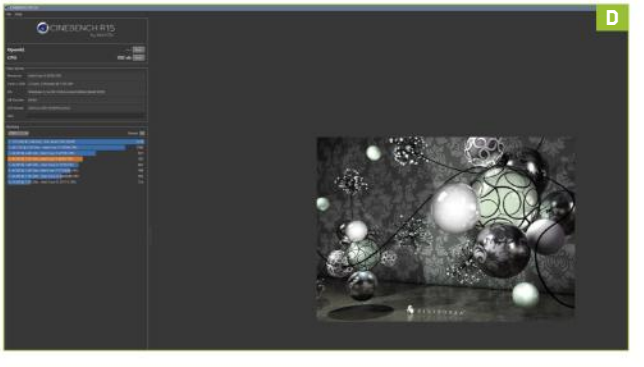

placed file, and it was goodnight Irene for your motherboard. These UEFI BIOS-enabled days, it's a reasonably simple process, so there's no need to read your hardware its rights, or call in any precautionary priests. Simply copy the BIOS file you downloaded in step two to a USB drive—the root directory is fine. Now reboot your PC, and press Del when the prompt appears. Welcome to the BIOS. Here you'll see a flash utility within the main options that enables you to select a new—or old—BIOS file, and install it. Simple.

## 4 ENABLE THE MAGIC SETTINGS

After the faintly terrifying BIOS installation bar has been filled and the machine restarts, re-enter the BIOS and head to the overclocking options. The exact options vary depending on your motherboard, but the important one is "SKY OC." This is the feature that disables turbo and integrated graphics, and allows big BCLK overclocking. On MSI boards, you need to enable "Expert mode" in the overclocking screen first, then enable "SKY OC." Your non-K chip is now ready to be buffed up [**Image C**].

## 5 SET YOUR INITIAL OVERCLOCK

Any BCLK value above 100 boosts the CPU's base clock—our Core i5-6500 can handle 135 with liquid cooling, for reference, but we recommend starting with 110, and increasing by 10 after every stable test. Increasing the BCLK also increases RAM frequency automatically, so you need to modify that RAM value to speeds you know your sticks can handle next. When you're setting the first stable overclock, don't go more than 100MHz above your RAM's advertised frequency. Our DDR4 modules can hack up to 3,200MHz, which allows plenty of headroom. The only other value to worry about is core clock voltage. You can crank this up to 1.35V without frying anything, and may be able to lower it again after setting stable values elsewhere.

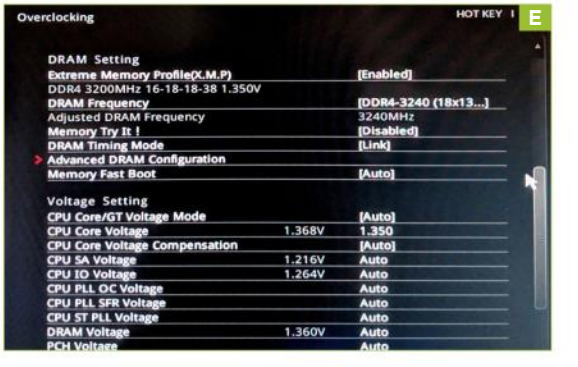

D

## 6 TEST IT OUT

If you set and saved your overclocked values, and your machine booted to Windows, that's a good sign. It doesn't mean you've achieved a stable overclock, though. You need to stress test your machine by running a synthetic benchmark in order to figure out whether your values are stable, so load up Cinebench R15 and run 5–10 CPU tests. After that workout, you'll either see a blue screen or know your numbers are solid [**Image D**].

## 7 TWEAK THE NUMBERS

So, you've got a stable performance boost for free, on a chip that was never intended to provide it. Hooray! What's next? Trying to squeeze still more performance out of it [**Image E**]. Obviously. Steady incremental increases of the BCLK value back in the BIOS is the next item on the agenda, then, although we can't stress enough that going beyond 1.35V is a risk/reward equation that simply isn't worth it. Limit yourself to that voltage, and then see what your CPU and RAM can handle by repeating step six. Eventually, you'll hit the ceiling, and at that point, you can enjoy the satisfaction of having performed a hardware upgrade for absolutely nothing.



E

# Speedy GPS Mapping Using Your Pi

**YOU'LL NEED THIS**

**USB WI-FI ADAPTER WITH MONITOR MODE**
Such as a TP-Link TL-WN72N.

**USB GPS MODULE**
We're using a U-Blox 7.

**ONE OF THE GREAT THINGS ABOUT THE RASPBERRY PI** is that it's so small and portable. To illustrate that fact while doing something interesting, this tutorial reveals how to configure a Raspberry Pi 3 to run from a car cigarette lighter socket while enabling the driver to collect Wi-Fi location and other data using a USB GPS and an external USB Wi-Fi module [**Image A**]. We then explain how to map this data using Google Maps.

Start off by grabbing the Raspbian Lite image file from www.raspberrypi.org/downloads/raspbian. Download and unzip the ZIP file. Ensure that only the image file is extracted. There should only be one file ending in .img at this point. Use Etcher (downloadable from www.etcher.io) to write out the image. Insert the microSD card and open Etcher. First, select the destination card, then click "Start." It takes several minutes to write and verify the image. **–STUART BURNS**

## 1 SET UP THE PI

Once the image is written to the card, unmount, remove, and reinsert it. Mount it as a fat32 disk. At this point, there should be a /boot partition mounted. To enable remote access, create an empty file called "ssh" in the boot folder with this command:

```
touch /media/boot/ssh
```

» Now unmount the card and place it in the Pi, then turn on the power. By default, the password for logging into the Raspberry Pi is "raspberry." The first item to sort is to enable the Pi to boot without the HDMI cable being plugged in. You need to log in to the Pi directly. Do this by editing the /boot/config.txt config file ( `sudo nano /boot/config.txt` ).Locate the line with `hdmi_force_hotplug=1` and uncomment it, then save on exit. It's also best practice to update the Pi's software.

## 2 TOTALLY WIRED

To set up remote access, the next step is to establish the wired Ethernet connection to install all the packages that this project requires. If you're pushed for time, it's possible to use the onboard Wi-Fi, but later on that is used to connect directly to the Pi, so it'll need to be reconfigured if you use wireless. Change the wired network configuration by using this command:

```
sudo nano /etc/network/interfaces
```

» Locate and change the "eth0" setting to a local network address using the lines below, substituting your IP addresses for the ones listed.

```
auto eth0
  iface eth0 inet static
  address  10.0.0.177
  netmask 255.255.255.0
  gateway 10.0.0.254
 dns-nameservers 8.8.8.8
```

» If you've not already done so, plug in the cable. Make the changes live using this command:

```
sudo service networking restart
```

» Check the IP address is working by using `ifconfig eth0` to make sure the changes have taken. Raspbian provides a tool for managing the Pi: raspi-config. This has several applications above and beyond updating. To use it, run the following command:

```
sudo raspi-config
```

» Select option eight (update). While in raspi-config, set a new password and hostname if desired, by using the appropriate options. When finished, move to the "Finish" button, and press Enter. A reboot may be required at this point. If so, reboot and reconnect using SSH, as done above. Now comes the interesting bits, such as configuring the GPS and USB Wi-Fi. Plug in the GPS receiver [**Image B**]. After a few seconds, it should have registered. To check that it can be seen properly, use this command:

```
sudo lsusb
```

## 3 CHECK THE GPS RECEIVER

This should show the GPS device as being listed (for this tutorial, the device is shown as a U-blox AG). If you're not sure, remove the device and repeat the command above, comparing the out result. For the GPS device to work, it needs to seen as a serial device. To see which device has been registered, you can use the following command:

```
sudo dmesg | grep -i usb
```

With our current setup, the device shows as "ttyACM0":

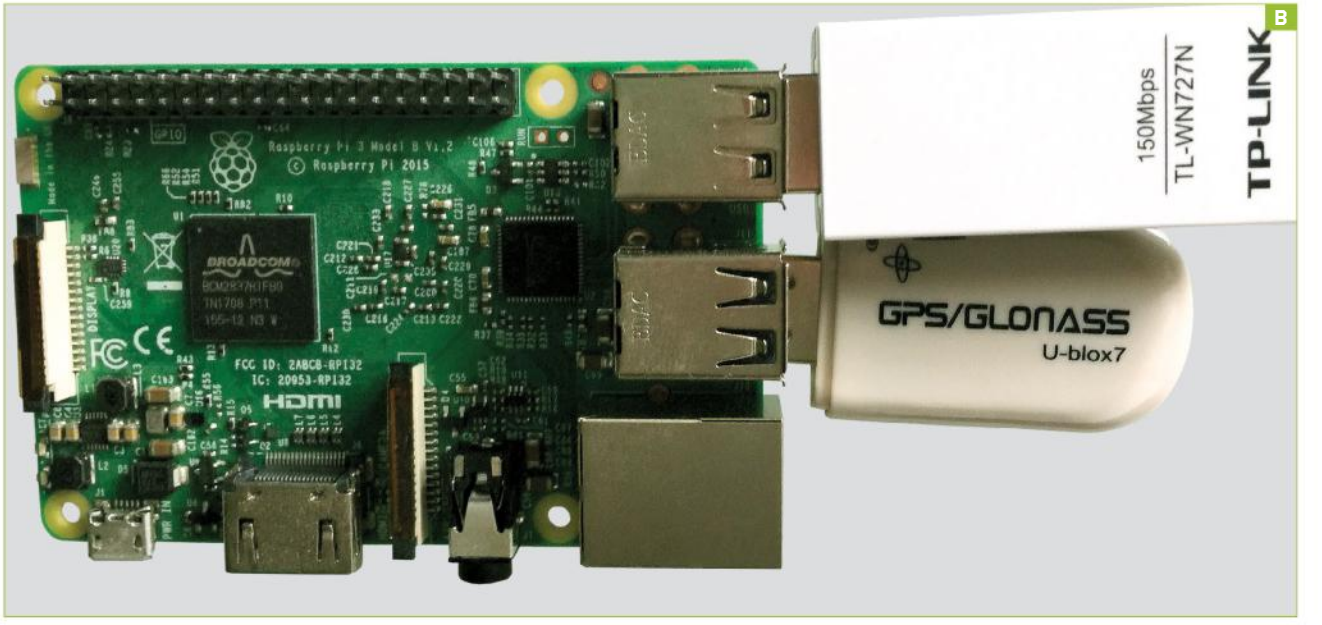
```
cdc_acm 1-1.2:1.0: ttyACM0: USB ACM device.
```

To check the correct device is being received, use this command to output the GPS data to the console.

```
sudo cat /dev/ttyACM0
```

» There are several ways to view the GPS data, including a command called `gpsd` . It has a few dependencies, some

A




of which are shared with the Kismet Wi-Fi scanner. First, install the following dependencies:

```
sudo apt-get install -y screen gpsd libncurses5-dev libpcap-dev tcpdump libnl-dev gpsd-clients python-gps ntp
```

» There are several options that need to be set for the GPS service to run properly. Edit the /etc/default/gpsd file ( `sudo nano /etc/default/gpsd` ) and modify the file in line with what's shown below. Some of the comment lines have been moved for brevity...

```
START_DAEMON="true"
USBAUTO="true"
DEVICES="/dev/ttyACM0"
GPSD_OPTIONS="-n"
GPSD_SOCKET="/var/run/gpsd.sock"
```

To turn on GPS location on boot, use the command `sudo systemctl enable gpsd.socket` .

» To check that it's working as expected, you can use the `cgps` command. This should show a nice formatted console screen, with a lot of GPS data, including your current co-ordinates and height above sea-level. Use Ctrl-C to exit it. If it looks as though it's not working, we advise checking the service is running as a first point (and potentially carry out a reboot if it's problematic). Use `systemctl status gpsd` . In addition, if the GPS doesn't pick up any co-ordinates, try hanging the device out the window. We found that double glazing stops the signal getting in!

## 4 TWEAK THE INTERFACE

Now is a good time to configure the WLAN1 Wi-Fi interface. First, ensure that the new controller can be seen by using the same `lsusb` command that was used earlier. Unfortunately, the out-of-the-box Wi-Fi built into the Pi 3 doesn't currently work for our purposes, because it doesn't support Monitor mode. For more on this, see the boxout on page 63.

» It should be noted that Monitor mode does just that. It monitors the network and never connects to any wireless networks—nor is it able to! Next, you need to install the Kismet software. This is the Wi-Fi scanning tool that we'll be using. Kismet has to be built from source; it can't just be installed because it's not available in the repos or a package. We're using the latest release at time of writing. Follow the commands below to download and install Kismet:

```
wget http://www.kismetwireless.net/code/kismet-2016-07-R1.tar.xz
tar -xvf kismet-2016-07-R1.tar.xz
cd kismet-2016-07-R1/
make dep
sudo make install
```

## 5 CONFIGURE KISMET

The whole process takes a long time (30 minutes or more, potentially) as it builds all the programs from source code. It can be compiled to run without using root, but that is beyond this introductory project. There are a lot of warnings, but they are nothing to worry about. Eventually, the system returns to the command prompt. Kismet can take command-line arguments, but in this scenario, the article uses the Kismet configuration file. The only item to be set is the interface to use. Edit the kismet.conf file:

```
sudo nano /usr/local/etc/kismet.conf
```

» Uncomment the line that reads `ncsource=wlan0` and also change `wlan0` to `wlan1` . It's now possible to run Kismet, and it'll detect all the various local network points and their geolocations. While it's not advisable to run Kismet as root, for our purposes it's fine. Run it by using the command `sudo kismet` . This loads the Kismet GUI and asks several questions. It's possible to use Tab to navigate around.

» The best startup procedure is to leave the settings in place. When asked if it's desired to connect to the Kismet server, make sure you press "Yes." The console log should hopefully start showing all the networks that it can currently locate [**Image C**]. Behind the scenes, the Kismet server also creates several groups of log files. Assuming

## QUICK TIP

While this tutorial has focused on using a Raspberry Pi, it's just as easy to set up the same configuration on a laptop. Most of the commands discussed here will work on any Debian-based system. Note: You'll need to check that your Wi-Fi card supports Monitor mode first.

the test run goes as expected, and there are log files in /home/pi, it's time to shut down the Raspberry Pi, and do it for real. To exit Kismet, use Ctrl-C.

## 6 ACCESS FOR ALL

The last big configuration item is setting up the wlan1 to be an access point. These configuration steps are based on the official Raspberry Pi guide (www.raspberrypi.org/documentation/configuration/wireless/access-point.md). This means that your laptop can see and connect to the Pi without having to worry about IP addresses. To set up this configuration, there are two items of software that are needed: dnsmasq and hostapd. Again, install them with:

```
sudo apt-get install -y dnsmasq hostapd
```

» The dnsmasq tool takes care of the DHCP angle, while the hostapd utility provides the items that are needed to configure the wireless access point. First, we need to change the way wlan0 works. Edit the DHCP configuration file ( `sudo nano /etc/dhcpcd.conf` ) and add the following entry to the bottom of the file:

```
denyinterfaces wlan0
```

## 7 CONFIGURE INTERFACE

You also need to set up the interfaces configuration for wlan0. Just like was done earlier when we set a static IP address for the wired network, the same needs to be done for the wlan0 interface. Edit it to use the following ( `sudo nano /etc/network/interfaces` ):

```
allow-hotplug wlan0
iface wlan0 inet static
  address 172.16.0.1
  netmask 255.255.255.0
  network 172.16.0.0
```

» Once set up, save the changes, and exit. Restart the services as detailed below. If you're not using a wired connection, the interface restart would cause issues. It's better to do a restart ( `sudo reboot now` ).

```
sudo service dhcpcd restart
sudo ifdown wlan0
sudo ifup wlan0
```

» Configure the DNS settings by editing the dnsmasq file ( `sudo nano /etc/dnsmasq.conf` ), and add the interface details as shown below:

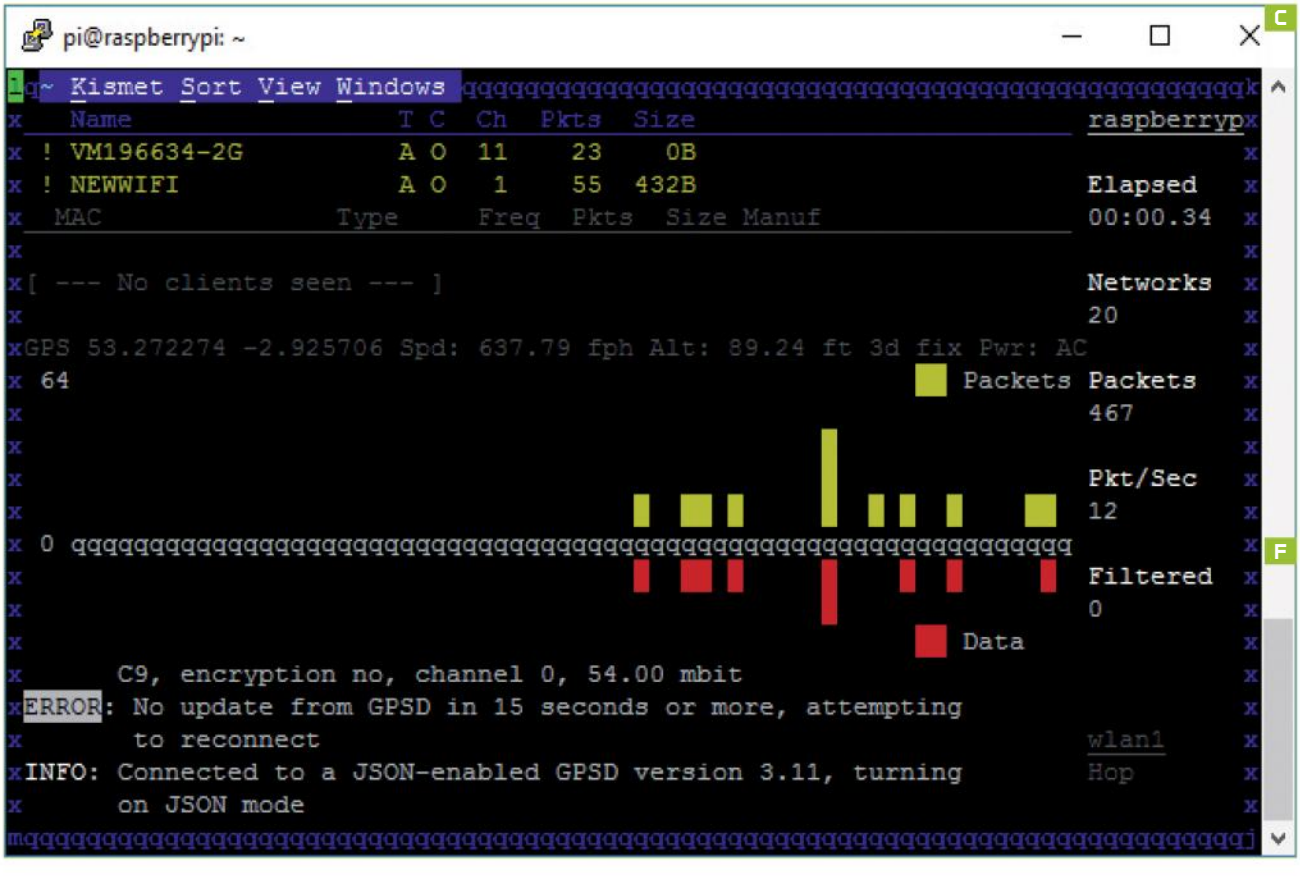
```
 interface=wlan0      # Use the require wireless interface - usually wlan0
  dhcp-range=172.16.0.2,172.16.0.20,255.255.255.0,24h
```

» Finally, set up the AP configuration file ( `sudo nano /etc/hostapd/hostapd.conf` ), adding the items shown below:

```
interface=wlan0
driver=nl80211
ssid=MyNetwork
hw_mode=g
channel=7
wmm_enabled=0
macaddr_acl=0
auth_algs=1
ignore_broadcast_ssid=0
wpa=2
wpa_passphrase=MyPassword
wpa_key_mgmt=WPA-PSK
wpa_pairwise=TKIP
rsn_pairwise=CCMP
```

» Edit the hostapd file, changing the `DAEMON_CONF` line to reflect that below (`sudo nano /etc/default/hostapd`):

```
DAEMON_CONF="/etc/hostapd/hostapd.conf"
```



## GET A HANDLE ON MONITOR MODE

So what's all the fuss about using an additional Wi-Fi card? In short, there are several modes that are potentially available on network cards. These modes include Monitor, Infrastructure, Mesh, and Managed, as well as a few others. Most of the time, users don't have to understand or make use of the modes. As a result, the hardware manufacturers don't spend much effort on making cards that work well with Monitor mode.

While putting this article together, it took several attempts to find a USB card that works for Raspbian. It's possible to find out which modes your network card works with using the command `iwconfig info wlan0` (or other wireless interface). This will give various groups of information, including details on supported modes. By default, Kismet configures the network card to use Monitor mode, so it doesn't have to be manually set.

It is, however, possible to make the card manually switch into Monitor mode by using the following commands:

```
sudo ifdown wlan1
sudo iwconfig wlan1 mode Monitor
sudo ifup wlan1
```

As previously noted, if you do this, the network will stop responding if you use it on the network interface you're connected through. It's set to passively monitor and report all networks it sees. The wireless card used in this tutorial was a TP-LINK TL-WN727N, purchased online for about $17. Do be sure to check its specs, though—there are a lot of similar cards that don't work.

» Turning on the services at boot is achieved with:

```
sudo service hostapd start
sudo service dnsmasq start
```

» Restart the service to instigate the changes:

```
sudo service ntp restart
```

### 8 TEST THE SETUP

To test the environment, shut down the Pi, and remove the Ethernet and HDMI cables. Power it up, connect to the newly created AP, and, from your laptop, access a remote shell into the AP point. Shut down, then place the Pi in your car. Be aware that the Pi may not boot properly if there's insufficient power. It may look powered on, but it doesn't fully boot. Check power requirements before doing anything. At a push, you can power it from your laptop's USB port. External battery packs are an option, too—be sure to read the manual, to ensure it can provide enough power.

» Assuming the Pi has powered up, and you can access it via `ssh`, run the Kismet application using:

```
ssh pi@192.168.0.1
sudo kismet
```

» Follow the earlier routine to access the Kismet console.

### 9 CONVERT THE DATA

Go for a short drive, then come back. All the data will have been collected automatically, and placed in files within the /home/pi folder. Use the laptop to gracefully shut down the Pi using the command `sudo shutdown -h now`. These files contain GPS data and Wi-Fi base station data, but are currently not in a format that Google Maps can understand. To do the conversion, we're going to use a script by Scott Helme to convert it into a mapping file. To do this, use the command:

```
wget https://gist.githubusercontent.com/ScottHelme/5c6869e17c3e9c8b2034dc8fc13e180b/raw/31c2d34f66748b6bd26415fd7d120c06b3d92eaf/netxml2kml.py -O netxml2kml.py
```

Or the following shortened link:

```
wget http://bit.ly/LXF230netxml -O netxml2kml.py
```

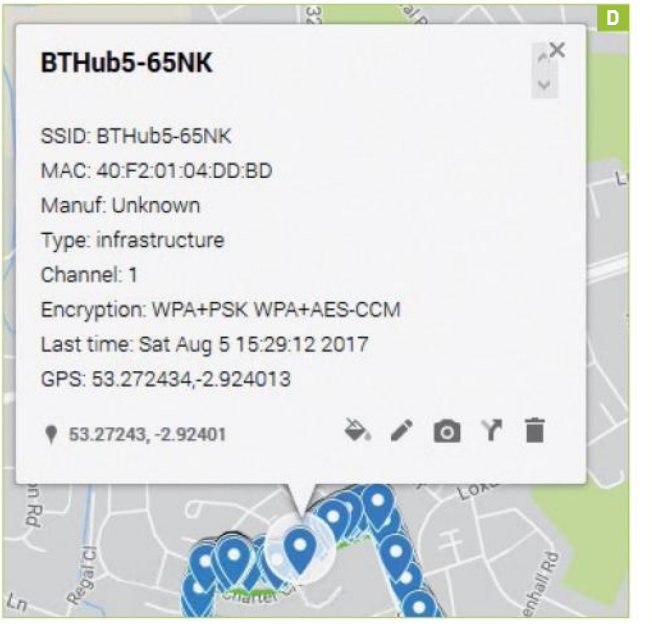
» To create the mapping file, run the command:

```
cd /home/pi
python netxml2kml.py --kml -o output *xml
```

It may take a minute or two, but it eventually delivers a summary of the Wi-Fi base stations found.

» Obviously, the data is still on the Pi, so it needs to be copied across. Copy the file using `scp` to your local PC, substituting values as needed. Use the following command to copy the data across from the Pi:

```
scp /home/pi/*.xml myuser@myworkstation:/home/myuser
```




### 10 IMPORT INTO GOOGLE MAPS

At this point, the data file should be in the current directory from which the command was run. The final step is to import the XML file into Google Maps (www.google.com/maps/d/home). Select "Create New Map." Add a layer. This will show a window that will enable the user to add the newly created file. This could potentially take several minutes to complete. Once done, you should be able to see all those Wi-Fi spots mapped, alongside various details of the protocols supported, and other interesting items [**Image D**].

» Create a raw Google Map. To import the data, select "Add New Layer," then click "Import." Drag in the saved file. It'll take a moment to upload and import the data. Once completed, the map shows the location, Wi-Fi station name, encryption schemes, and other data.

» We hope that this guide has been useful. There are many other additions and configurations that can be applied upon the foundation of this fun project, but that's for you to experiment with. Please let us know how you get on—this is your chance to inspire other *Maximum PC* readers and the entire Raspberry Pi community.

# Play Red Alert On Your Raspberry Pi

### YOU'LL NEED THIS

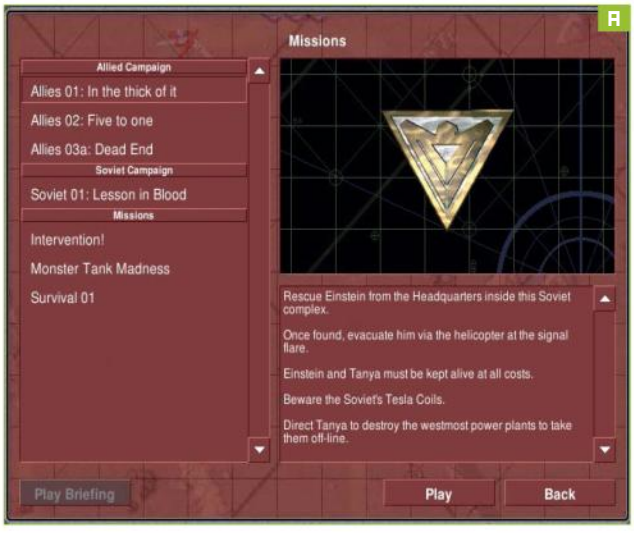
**RASPBERRY PI 3**
With a clean install of the latest version of Raspbian Stretch.

**COMMAND AND CONQUER: RED ALERT**
Plus the OpenRA game engine.

**HITLER'S TIME TRAVEL EXEMPTION ACT,** as decreed by the website TV Tropes (www.tvtropes.org), states that all fictional attempts by time travelers to murder the Great Dictator will either fail or otherwise be disastrous. This is, in fact, the exact premise upon which Westwood Studio's 1996 classic game *Command and Conquer: Red Alert* [**Image A**] is based. In the alternate history of *Red Alert,* Einstein decided to turn his genius to creating a time machine, rather than an atom bomb. He travels back to 1924, and kills Hitler with no more than a handshake. With no opposing Germans, the Soviet Union under Josef Stalin begins to roll across Europe, while the Allies desperately try to halt their advance. The game is non-judgemental, and lets you play as either faction.

Twenty years on, this excellent RTS (real-time strategy) game is now eminently playable due to the fan-made free and open-source OpenRA engine, enabling you to play *Red Alert* and other Westwood classics directly on your Raspberry Pi. Although you can technically play these games using emulators such as DosBox and Exagear, we feel that taking the OpenRA option makes for a much smoother gaming experience.

In order to proceed, all you need is a Raspberry Pi 3 with a clean install of the latest version of Raspbian Stretch. Make sure you run `sudo apt-get update` then `sudo apt-get upgrade` before downloading the OpenRA files. **–NATE DRAKE**


A
Missions
Allied Campaign
Allies 01: In the thick of it
Allies 02: Five to one
Allies 03a: Dead End
Soviet Campaign
Soviet 01: Lesson in Blood
Missions
Intervention!
Monster Tank Madness
Survival 01
Rescue Einstein from the Headquarters inside this Soviet complex.
Once found, evacuate him via the helicopter at the signal flare.
Einstein and Tanya must be kept alive at all costs.
Beware the Soviet's Tesla Coils.
Direct Tanya to destroy the westmost power plants to take them off-line.
Play Briefing
Play
Back

### 1 THE SPICE MUST FLOW...

The *C&C* franchise kicked off with the original *Command & Conquer* (sometimes called *Tiberian Dawn),* which was released in 1995. This, in turn, was based on Westwood's desire for a more realistic RTS game after the release of the archetypal *Dune II: Battle for Arrakis* in 1992. OpenRA supports playing these *C&C* titles, as well as *Dune 2000,* a partial remake of *Dune II.*

›› Both the original *C&C* and *Red Alert* games have also been released as freeware by Electronic Arts. Follow the steps in the boxout opposite to get OpenRA running. On first launch, the engine asks you to "Choose your Battlefield" [**Image B**]. From there, you can select your chosen game. OpenRA can download the game files for each title for you. However, if you do have the original CDs, consider using these instead, because the downloaded files don't contain any sound or video sequences.

›› If you decide to use a CD, you need an external DVD drive connected to a powered USB hub to read it from the Raspberry Pi. Alternatively, copy the ISO file to a USB

## BOOST YOUR WAR MACHINE

Despite the age of the games, gameplay within OpenRA is very sluggish on the Raspberry Pi by default—with the exception of *Dune 2000.* You can tinker with this from within the games themselves by entering the "Settings" menu, and altering the frame rate. You can also change the "Mode" from the default ("Pseudo-fullscreen") to "Windowed," and even specify the window size. Click "Reset" to return the settings to their defaults, or click "Back" to confirm your changes. The game then restarts. Getting the resolution right can be tricky. If you make a mistake, open Terminal, and run `nano ~/.openra/settings.yaml`. From here, you can change the "Graphics Mode" and "Window size."

If you want to give your Raspberry Pi a real shot in the arm, you could try enabling the experimental OpenGL driver. Close any open applications, then open Terminal. Run `sudo raspi-config`, and use the arrow keys to choose "Advanced Options." Next, choose "A6 GL Driver." Enable the first option starting "G1 (Full KMS)." The Pi's "Advanced Options" section also contains a "Memory Split" option, whereby you can choose to increase the dedicated amount of memory for the GPU, which may also improve performance. Choose "A3 Memory Split" under "Advanced Options" to change this from the default (64MB) to a higher value—256MB, for example.

Use the arrow keys to select "Finish," then choose "Yes" to reboot the Pi. Hopefully, you'll find the tide of battle flowing a little faster now....

stick, and connect it to the Pi. Open Terminal, and create a mount point, such as `sudo mdkir -p /mnt/disk`. Next, use `cd` to switch to the directory with the ISO file, and mount the ISO file itself using the `mount` command, for instance:

```
cd /home/pi/Desktop
sudo mount CD2_SOVIET_DISC.ISO /mnt/disk/ -t iso9660 -o loop
```

›› OpenRA detects that the files are mounted, and copies the game data next time you launch.

## 2 MULTIPLAYER MODE

Once you've managed to indulge your nostalgia by fighting the enemy AI, you may wish to share the experience with other players. The good news is that OpenRA is available for all major platforms, so you should be able to play against your friends, no matter what OS they are running. After you've compiled the code, open Terminal, and use `cd OpenRA` to switch to the game folder, then `sudo cp /usr/lib/openra/launch-dedicated.sh /usr/lib/openra/my-dedicated.sh`. You can then edit your game server settings by running `sudo nano usr/lib/openra/my-dedicated.sh`. Amend `Game.Mod=ra` to `Game.Mod=cnc` or `Game.Mod=d2k` to play the original *C&C* and *Dune 2000* [**Image C**] respectively. Set a password for your server by amending `Server.Password=PASSWORD`. For more information, see https://github.com/OpenRA/OpenRA/wiki/Dedicated.

›› If your friends are connecting via the Internet, you need to set up port forwarding on your router. Specific steps for this vary from router to router. However, you can find some tips for getting started at http://portforward.com, which covers all major models. By default, the server uses TCP Port 1234.

## 3 FOG OF WAR

The official position of the OpenRA project is that the engine can run on Raspbian, but games cannot be played on the Raspberry Pi itself (see https://github.com/OpenRA/OpenRA/wiki/OpenRA-on-RaspberryPi). Although this doesn't seem to be true in practice, the developers do warn that you may see the heat indicator at the top-right of your Pi's screen. Although this didn't happen during our (brief) tests, if you see the indicator, you must switch off your Pi immediately to avoid permanent damage. This warning doesn't affect using the Pi as a dedicated OpenRA server.

Once the OpenRA engine has been compiled, and you've followed the steps in the "Boost Your War Machine" box (opposite) to improved your emulated gaming experience, you'll hopefully agree with our view that it's far better to play classic games in a custom engine than through a clunky emulator. This said, OpenRA doesn't claim to be an exact recreation of the original games, so you may find that play doesn't quite reflect what you remember when looking back through rose-tinted spectacles.

Specifically, OpenRA has introduced certain special visual effects, such as leaving trails behind aircraft, as well as altering the interface. Modders will also be pleased to hear that the engine has dispensed with one almighty INI file in favor of a series of modular YAML files. This allows for much finer control of the game, such as changing the sounds for individual units and weapons.

If your hunger for real-time strategy games has been whetted, and you want to see what OpenRA comes up with next, either visit www.openra.net, or join the conversation at irc://chat.freenode.net/openra.

# SET UP OPENRA

### 1. CLONE THE GAME ENGINE

Open Terminal on your Pi, and enter `git clone https://github.com/Mailaender/OpenRA`. The game engine starts to download. Once the download is complete, switch to the directory with `cd OpenRA`, then install the necessary software to compile it by running `sudo apt-get install nuget mono-complete liblua5.1-0 libsdl2-2.0-0`. Next, press Y to proceed with the installation.

### 2. MODIFY THE CONFIGURATION FILES

Once the software dependencies have been installed, run `nano configure` from Terminal. On line six, change `usr/lib/i386-linux-gnu` to `/usr/lib/arm-linux-gnueabihf`. Press Ctrl-X, Y, then Enter, to save and exit. Next, enter the command `nano Makefile`. Scroll down to line 36, and change `dmcs` to `mcs`. Save and exit in the same way.

### 3. COMPILE OPENRA AND DOWNLOAD FILES

From Terminal, run `./configure`. Next, run `sudo make dependencies`. To compile OpenRA itself, run `sudo make all`. Once the game has compiled, you can run it at any time by switching to the OpenRA directory, and entering `./launch-game.sh`. Choose your game, then download the necessary game files.

# Manage Your Media With Kodi

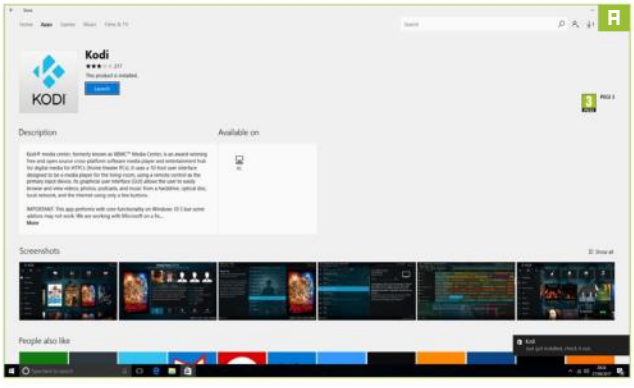
## YOU'LL NEED THIS

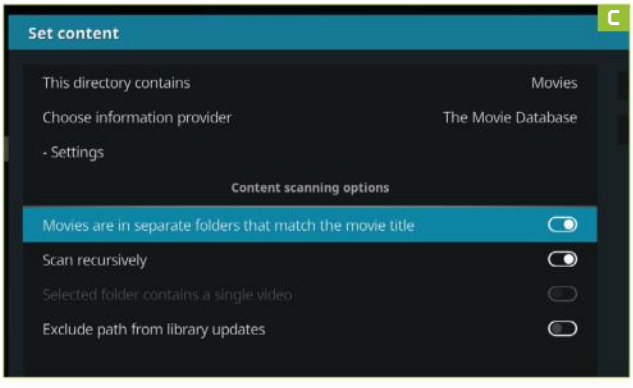
**KODI**
Download the app from https://kodi.tv/download.

**KODI IS AN EXTREMELY VERSATILE** open-source application. It offers a very elegant way to manage all your TV shows, films, and music in one place. Each aspect of Kodi can be changed, from its themes (known as "skins") to the addition of various plugins, which support extra features, such as YouTube playback.

One particularly useful feature concerns Kodi's video and audio scrapers. These scour the Internet to match your media files to a particular film, TV show, or song. The resulting metadata is then displayed in the application.

The Kodi project is dedicated to turning your PC into a home cinema. To this end, the application also supports a number of remotes, such as official touchscreen apps for cell phones, and even game controllers. See http://kodi.wiki/view/Remote_controls for a full list of compatible devices. Now, join us as we show you how to set up and use Kodi. –NATE DRAKE




### 1 UPDATE WINDOWS

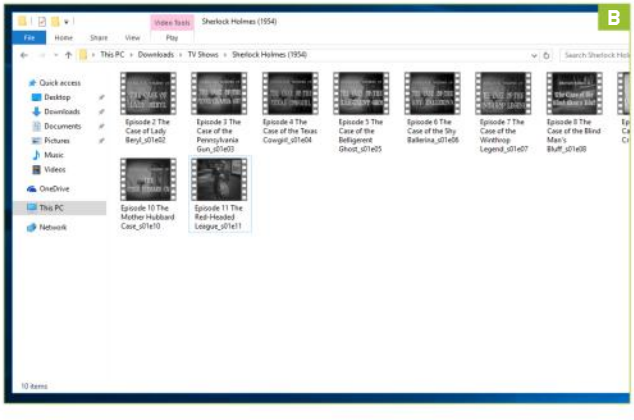
Kodi only works with the latest version of Windows 10. You can check whether your system is up to date by heading to "Settings → Update & security → Windows Update." Save and back up any files that you're currently working on, then click "Check for updates." If your PC needs to reboot, let it do so, because you won't be able to install Kodi until the update is complete.

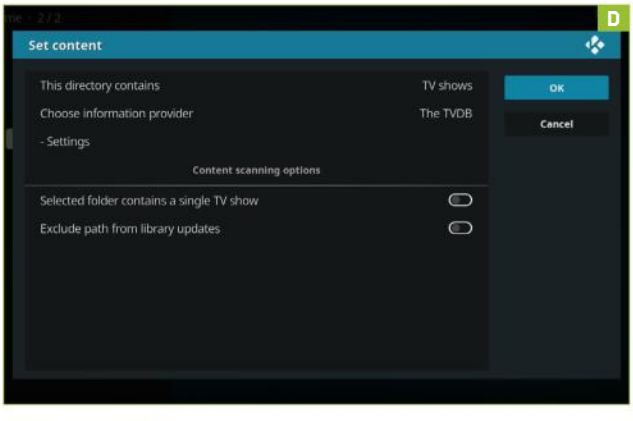
### 2 DOWNLOAD KODI

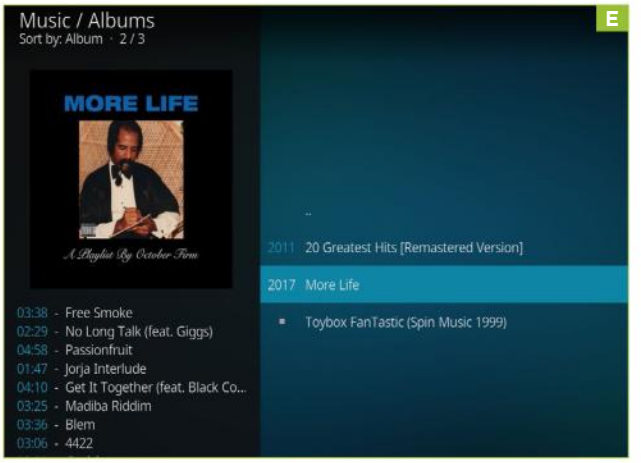
Fetch the latest stable version of Kodi by opening the Windows Store, and typing "Kodi" into the search bar [Image A]. Click "Get" to install it on your machine. If you want the most up-to-date version of Kodi, open your browser, and navigate to https://kodi.tv/download. Click "Windows" under "Choose your weapon," then "Nightly Build." When you first launch Kodi, the Windows Firewall displays an alert. Click "Allow Access."

### 3 RENAME YOUR MEDIA

If you want Kodi to recognize your films and TV shows, you need to name them correctly. Open File Explorer, and head to your video collection [Image B]. Rename films using "Name (Year)"—"Night of the Living Dead (1968)," for example. Rename TV shows using




E
Music / Albums
Sort by: Album · 2 / 3
MORE LIFE
2011 20 Greatest Hits [Remastered Version]
2017 More Life
Toybox FanTastic (Spin Music 1999)
03:38 - Free Smoke
02:29 - No Long Talk (feat. Giggs)
04:58 - Passionfruit
01:47 - Jorja Interlude
04:10 - Get It Together (feat. Black Co...
03:25 - Madiba Riddim
03:36 - Blem
03:06 - 4422

"Name_sXeY"—"Adventures of Superman_s01e03," for example—then place them inside a folder with the name of the TV series.

## 4 ADD MOVIES

Click the "Start" menu, then "Kodi" under "Recently Added." Kodi now launches in full-screen mode. Use your mouse or the arrow and Enter keys to navigate and choose options. First, hover over "Movies," then click "Add Videos." The "Add Video Source" window opens. Click "Browse," navigate to the folder where you keep your film collection, then click "OK."

## 5 DEFINE CONTENT

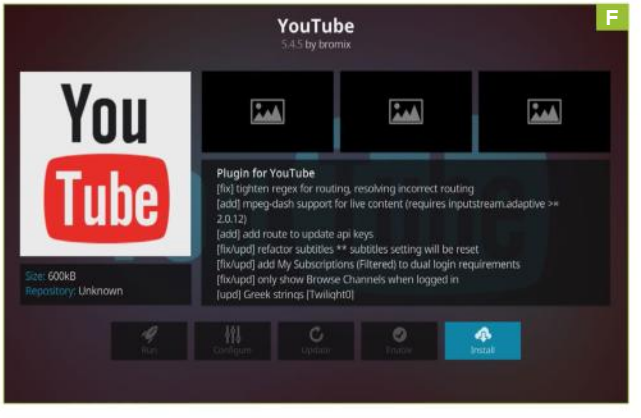
Once you've set the video folder, the "Set Content" window appears. Click the word "None" beside "This directory contains." You can now specify that this folder contains "Movies." By default, information about films is taken from The Movie Database. Under "Content Scanning Options," you can specify whether the movies are in individual folders or not [**Image C**]. Finally, click "OK."

## 6 ADD TV SHOWS

Kodi now asks if you want to refresh information for your items. Click "Yes," then press Esc to go back to the main screen. Hover your mouse over "TV Shows," then click "Enter Files." Browse and select the folder containing your TV shows in the same way as you did for movies. In the "Set Content" window, click "None," and specify that the content contains "TV Shows" [**Image D**].

## 7 ADD MUSIC

Kodi supports music playback. Press the Windows key to show your Taskbar, or exit Kodi and navigate to your music. Name tracks using the "Track number-Artist-Song name" format—


F
YouTube
5.4.5 by bromix
Plugin for YouTube
[fix] tighten regex for routing, resolving incorrect routing
[add] mpeg-dash support for live content (requires inputstream.adaptive >= 2.0.12)
[add] add route to update api keys
[fix/upd] refactor subtitles ** subtitles setting will be reset
[fix/upd] add My Subscriptions (Filtered) to dual login requirements
[fix/upd] only show Browse Channels when logged in
[upd] Greek strings [Twilight0]
Size: 600kB
Repository: Unknown
Install

"04-Toybox-Tarzan and Jane," for example [**Image E**]. Relaunch Kodi, and choose "Music," then "Enter Files." Enter the path to your music folder in the same way as before. Under "Set Content," choose "Music."

## 8 INSTALL THE YOUTUBE ADD-ON

Kodi supports extra features, including the official YouTube add-on, which can both search for and play videos. Return to the main menu, and choose "Add-ons → Enter add-on browser." Select "Video add-ons," then scroll down to "YouTube." Double-click and select "Install" [**Image F**]. You can now access YouTube from the "Add-ons" menu. Click "Search → New Search" to look for videos.

## 9 CHANGE SKIN

In Kodi, your chosen skin governs the look of the interface you use to manage and play your content. This includes the layout of menus, the background, and, in some cases, extra icons and features. By default, Kodi uses the rather austere Estuary skin. But you can change this to something more visually appealing [**Image G**]. To do that, head to "Add-ons → Look and Feel → Skin."

## 10 CONFIGURE SETTINGS

Click the "Settings" icon at the top-left to change Kodi's settings. The menus are categorized, so this should be fairly self-explanatory. For instance, to optimize Kodi for use with touchscreens, go to "Skin Settings → General → Touch Mode." You can also fine-tune your playback settings. Click the button at the bottom-left to switch between "Basic" and "Advanced" [**Image H**].

# Create an HDR Image from One Photo

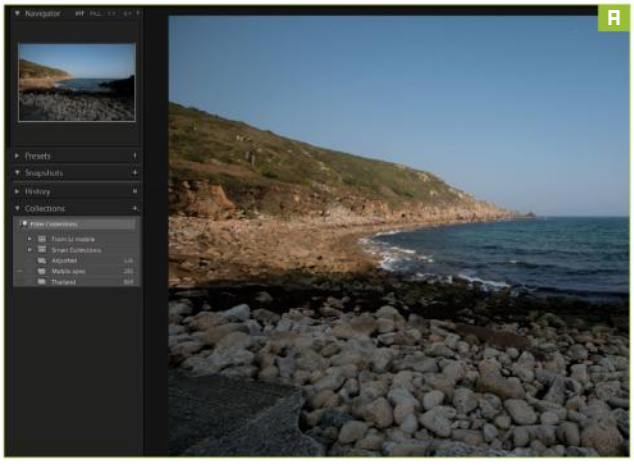
## YOU'LL NEED THIS

**AFFINITY PHOTO FOR WINDOWS**
Ten-day trial available from https://affinity.serif.com.

**LIGHTROOM**
Subscribe to various Adobe software subscriptions at www.adobe.com.

**HDR, OR HIGH DYNAMIC RANGE,** photography was enormously popular a couple years ago, then became so ubiquitous that even your cell phone can do it today. The idea is that you shoot three—or sometimes more—photos. One of them is normally exposed, one is overexposed, and the third is underexposed. You do this on a tripod, so they're identical, then blend them in software, so the mid-tones come from the properly exposed photo, the darks from the underexposed, and the brights from the overexposed one. This makes a higher contrast final image that doesn't suffer from a lack of detail in dark or bright areas, as can be the case from a single image, thanks to the way the sensors in digital cameras are built.

One of the problems with HDR is that it's easy to do badly, and end up with a garish mess. Supersaturated blue skies are common, and other colors can be portrayed equally unrealistically. Software comes to our rescue, however, and for once it's not Photoshop. **–IAN EVENDEN**




### 1 RAW DEAL

To do this, you're going to need a camera that can shoot in Raw. These files are the unedited data from the camera's sensor, often at a depth of 12 or 14 bits, and contain more tonal data than is expressed in JPEGs, which are usually 8-bit. Frame your image so it contains light and dark areas—these are what you want to bring out in the final blend. It's still a good idea to use a tripod and either a cable release or self-timer, even if you're not planning on taking multiple bracketed exposures, because the additional sharpness of fine detail the stable platform enables is always welcome. The beauty of doing it this way, especially with a seascape, is that everything is guaranteed to be in the same place in each image, because a wave or distant bison can move a long way in the time it takes to rattle off three separate shots.

### 2 DEVELOPING SKILLS

Import your Raw file into Adobe Lightroom—we're using Lightroom Classic—or another Raw image workflow app. You could do the whole thing in Affinity Photo, beginning in the Develop Persona, if you wanted, but we've got a soft spot for Lightroom. Work on the image until you're happy, then export it as a JPEG. In the Develop window, reduce the exposure to -1.5 stops, export a new file, then increase it to +1.5 stops, and export again [**Image A**]. These are the three files you will use to create the HDR image, just as though you'd shot three frames with differing exposure settings.

### 3 SET THE TONE

Open Affinity Photo. If you've not bought the app, there's a 10-day free trial available. Hop up to the "File" menu and select "New HDR Merge." A window appears in which you can choose the files that will make up your project. We've left "Automatically align images" and "Tone map HD image" checked, which they were by default, before hitting "OK." Once it's done merging, you're taken to Affinity's Tone Mapping Persona, and presented with a series of preset choices for a final look, with options such as high contrast black and white, and "Dramatic" [**Image B**]. On the right are a few sliders for controlling the tone mapping in the image, which is the way the newly expanded dynamic range in your 32-bit document is wrangled into something that can be displayed on a typical monitor, or saved as a JPEG. At the top-right is a useful before-and-after split view button, with a divider that can be swept back and forth across the image.

### 4 LET IT SLIDE

The sliders on the right are where you take control of the process. There aren't many, but some are capable of making enormous differences to your final

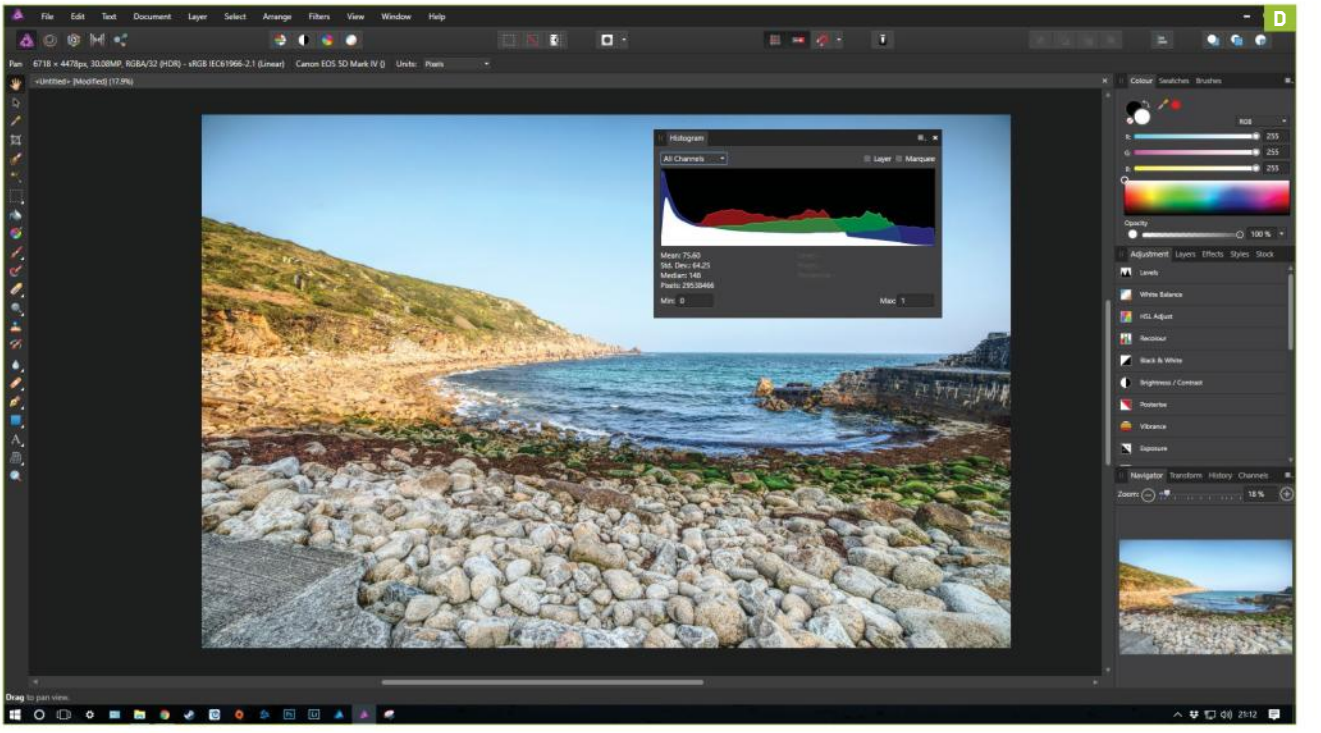


image. Right at the top, you'll find "Tone Compression," which is at 100 percent by default, and controls how many out-of-range tones are brought within the range. Leaving it at 100 percent gives you a brighter image, with trips down the percentage scale resulting in an increasingly dull look. Below it is "Local Contrast," which is one of our favorites, but must be handled carefully. We've pushed it all the way to 80 percent [**Image C**], and the difference is easily seen in the split view—there's much more contrast everywhere, and the image seems sharper all over. It doesn't look exactly natural, though, and there's clearly been some processing going on, even if the sharp new look is rather eye-catching. However, we might be able to tone it down with the other options.

## 5 GO INTO DETAIL

Heading on down, we have "Exposure," "Blackpoint," and "Brightness," all of which control the brightness of the image. Then "Contrast," "Saturation," and "Vibrance," which control the colors. We don't want to touch "Contrast," for fear of what it might do to our already contrasty image, but if yours is lacking in that area, it's often the first slider to reach for. Then there are "White Balance" (which was taken care of at the Raw development stage), "Shadows," and "Highlights," which can be useful if you've got too much of one in your image. "Detail Refinement" is like a sharpening tool for your image. By default, this is set at 50 percent for "Radius" and 30 percent for "Amount." We slackened "Radius" off to 30 percent in the pursuit of a more natural-looking result. Right at the bottom is a curves adjustment you can play with, if that's your thing.

## 6 PICTURE PERFECT

When you think you've finished, hit the "Apply" button at the top-left, and you're taken to Affinity's main Photo Persona after a small amount of processing time. You can see from the histogram [**Image D**] that the tones are spread completely across the range. Your image will be kept in the 32-bit color space until you export it, or you can save it as Affinity's native file format to keep the extra depth.

## WHAT IS A HISTOGRAM?

A display of all the information in your image, running from dark on the left to light on the right, a histogram is a quick way to identify whether your image is well exposed. Peaks bunched up at either end signify an image with large dark or light portions, and those that vanish off the edge are clipped to pure white or black, with no detail discernible in them by even the keenest eye. Adjustments such as "Levels" or "Curves" can be seen working on the histogram, as their effect is to change the position of tones. Increase the brightness of an image dramatically, and you'll see the peaks bunch up at the right-hand side. A well-exposed image has data in almost every part of the histogram, with a smooth curve peaking in the middle considered ideal.

# BUILD IT

**ALEX COX**, CONTRIBUTING EDITOR

# Monochromatic Perfection

$1,900 of balance with this yin and yang build

LENGTH OF TIME: **2–3 HOURS** | LEVEL OF DIFFICULTY: **EASY**

## THE CONCEPT

**FOR MOST OF THE FREELANCERS** here at *Maximum PC*, the workhorse machines in our daily lives are typically paradoxes. The digital equivalent of the ship of Theseus; every part of them transplanted and replaced over the past decade, until nothing of the original truly remains. So, are they still the same PCs? More to the point, for this humble writer, has it really been a decade since we last sat down with a desk full of components and built a rig from scratch? The former question will remain paradoxical, but the latter has a new answer: no. We've built a new machine to escape the ridicule and derision of the *Maximum PC* team, and bring our lumbering skills back up to scratch.

As is, no doubt, hugely apparent, a massive part of our decision-making process when speccing up this machine was our desire for an alternate aesthetic. The black-based glowing RGB monolith is a modern staple, but we've added contrast and brightness, pulling out lurid color in favor of a slick monochrome combo. Liquid cooling is all the rage, but without the budget for such frippery (and with a mind to do something different yet traditional), we've opted for massive negative pressure airflow. All components included, there's a total of 10 fans spinning away inside.

Our sub-$2,000 budget (and that overarching color scheme) really determined the makeup of the PC itself, but even after splurging on fancy fans, we've not been forced to skimp on the goods. It's landed squarely at the mid-range, with Intel's 4GHz, quad-core Core i3-8350K (probably the best overclockable chip you can get with limited cash right now) sitting at its heart.

## MONOCHROME MEDITATION

**APPROACHING A FRESH**, modern case as someone who's scraped their knuckles on cheap Chinese boxes in the past is a revelation. While so many aspects of the PC building process have remained familiar over the past 10 years, there's an astonishing level of logic, flexibility, and build quality evident in NZXT's white-outered H400i microATX mini tower case. It's made for cable routing, for pretty builds, for compact constructions, for a subtle first glance, and a remarkable second, and it's just brilliant to work with.

Getting massive airflow into the case meant ripping out the stock fans and raiding Noctua's warehouse for a stack of cooling gear, namely a foursome of NF-A14 140mm fans for the rear and front of the case, an NF-F12 fan for rear exhaust, and a pair of the same to replace the decidedly not-monochrome brown fan of the NH-U12S cooler. Each fan includes replaceable corner vibration dampeners in a host of colors—critically, for us, four each of black and white. Topping it all off is a white NA-HC2 cooler cover to make the CPU pop and complement the H400i's cable tidy bar.

It might seem like we've chosen the components specifically for their hue: the gloomy Asus ROG Strix Z370-G mobo, the bright glossy Asus GeForce GTX 1060, the white LED brilliance of Corsair's Vengeance RAM, the mat ink of a 500GB Samsung 850 Evo SSD up front on display, the milky braided modular tentacles of the Corsair RM750x PSU. And we have. But, damn, that Core i3-8350K needed a collection of capable counterparts to really make it fly, and that's precisely what we've offered it. For a mid-range build, we'd expect this to burn through the benchmarks right now, and give us plenty of room for future expansion.

### INGREDIENTS

| PART | | STREET PRICE |
|---|---|---|
| CPU | Intel Core i3-8350K | $180 |
| GPU | Asus GeForce GTX 1060 6GB Dual | $300 |
| Motherboard | Asus ROG Strix Z370-G Gaming microATX | $185 |
| RAM | 16GB (2x 8GB) Corsair Vengeance White LED DDR4 | $253 |
| M.2 SSD | Kingston KC1000 M.2 PCIe SSD 480GB | $265 |
| 2.5-Inch SSD | Samsung 850 Evo 500GB | $180 |
| PSU | Corsair RM750x White PSU + Cable Kit | $150 |
| Case | NZXT H400i microATX White Mini Tower Case | $150 |
| CPU Cooler | Noctua NH-U12S | $64 |
| Accessories | Noctua NA-HC2 Chromax White CPU Cooler Cover | $20 |
| Fan 1 | 3x Noctua NF-F12 PWM Chromax Black Swap 120mm Fans | $69 |
| Fan 2 | 4x Noctua NF-A14 PWM Chromax Black Swap 140mm Fans | $100 |
| Total | | $1,916 |

## 1 GET NAKED

**STARTING FROM SCRATCH** is both the best way to get your head in a build and the key to a clean, organized machine. Gaining full access to that case means tearing it to shreds at the beginning. Everything that can be removed needs to be removed, including the front panel and dust filter, the tempered glass side and white rear cover, the nifty cable tidy bar (which takes a bit of bending to free it), and the stock fans. With as much elbow room as possible freed up inside, it's time to start working from the bottom up, pressing the padded rear port panel into place, then bolting down the mobo after screwing in an extra pair of standoffs to support it.

## 2 CABLE CONUNDRUM

**ALTHOUGH THERE'S LOTS** of room to stuff cables into the rear of the H400i's PSU bay, we've gone for a modular PSU, because even the copious routing channels on the rear panel will get overloaded by a full contingent of individually braided strands. Before installing the PSU, we added only those cables that were absolutely necessary, plugging them into the left-most sockets to minimize the wrist-twisting acrobatics required to add outlets if upgrading in the future, then removed the PSU bracket from the rear of the case, screwed it on to the PSU, and posted everything in, sending the cables out the back of the case to be properly routed later on.

## 3 FAN FINAGLING

**BEFORE THE CASE GETS TOO CROWDED,** and with the motherboard and PSU safely in place, it's time to install the case fans. This is a dull, arduous process that means adding eight awkward silicon vibration dampeners to each edge of each corner of each fan, being mindful of the airflow direction of each fan—we're dragging air in through the front, and exhausting it through the top and rear of the case. We chose to add the white bumpers to the fan side facing the inner of the case, so we only needed to consider the rotational orientation of the fans (and the egress of their cables through the back of the case) at install time; had we instead put them on the window side, we'd have had to consider the cables much earlier.

## 4 HOOK IT UP

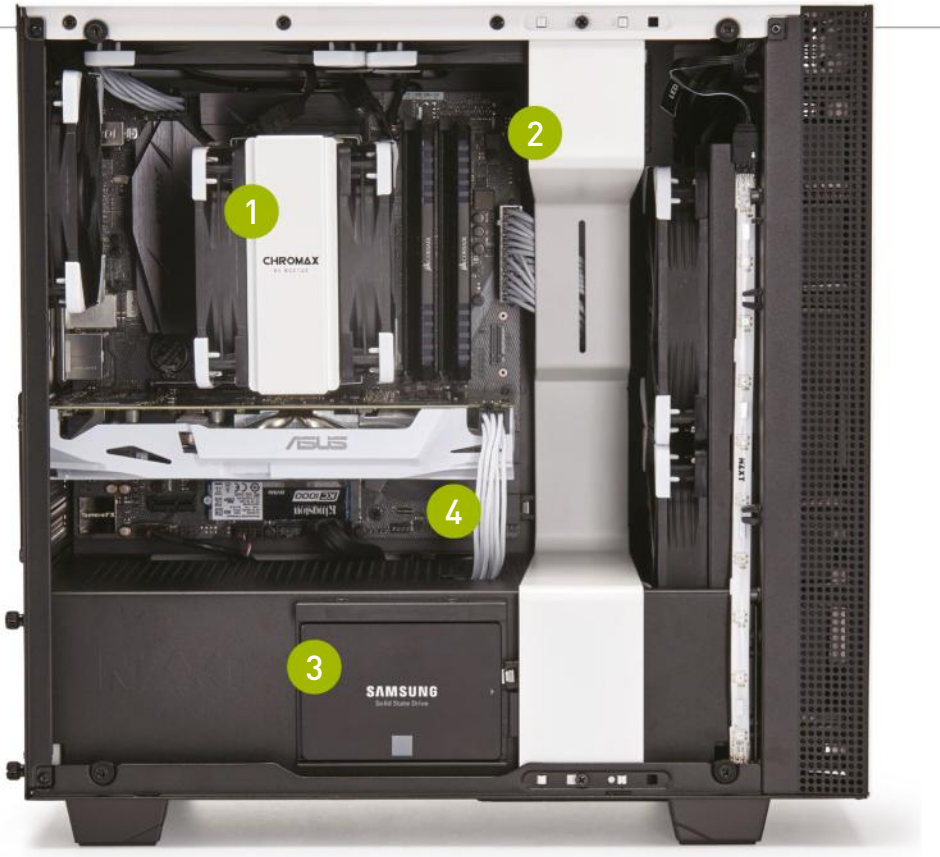
**HERE'S A BIT OF INSIDE INFORMATION:** We made it through this build with only one tiny finger wound, and it's not entirely clear where that came from. We blame our atypical lack of injury mainly on the formulaic, logical, top-down outside-in build process we employed. Thus the next step: installing those painful motherboard cables and headers that require improbable finger gymnastics if there's anything else in the case, and routing them neatly out of the way at this early stage. Then it's in with the RAM—in the motherboard's second channel, to ensure good clearance from the fan-laden cooler—in with the CPU, and in with the Kingston M.2 SSD, after liberating it from the PCIe card it initially comes attached to.

## 5 COOL IT

**ODDLY, INSTALLING THE CPU COOLER** is one of the trickiest bits of this build. It requires a bit of pre-preparation, pulling the brown Noctua fan off (and keeping it carefully aside, because it's awesome, and the only reason we're not using it here is its color), and removing its wire clips, then preparing the pair of 120mm fans, equipping them with clips, and considering both the direction of airflow and the location on the motherboard of the CPU fan headers. Bracket on, cooling paste on, cooler on. We then clip on the fan that's furthest from the fan headers, plugging it into the OPT header, which will become inaccessible once we've clipped on and plugged in the one on the other side. The magnetic mount for the cooler cover needs to be added next, followed by the second fan, then the white cooler cover simply drops on over the top.

## 6 FINAL STEPS

**TIME TO FINISH UP,** and it's a relatively simple process. The Samsung SSD goes in the cradle on front of the PSU bay—route the SATA cable and power through the handy hole next to it, and catch the flying springs that are released when you pop the cradle off—and then we install the graphics card; we initially routed the six-pin power cable through the back of the machine, and later moved it to the much more attractive hole on top of the PSU bay. With all the components ensconced, the cable tidy bar reinstalled, and the cables beautifully routed on the back, and definitely not all stuffed haphazardly into the main recess, the front and sides of the case can go back on at last.




1 **Without the bright white cooler cover, this machine wouldn't have nearly the same impact. It's a real highlight, well worth the small investment.**

2 **The cable tidy bar is a lovely touch, and another visual win. It's notched, so you won't have trouble fitting a full-length graphics card in the case.**

3 **Mounting our SSD here is a little ostentatious, but there is a pair of additional 2.5-inch mounting bays hidden in the back of the machine if we were thinking of being more discreet.**

4 **We love the spaghetti of the PSU's modular cabling, particularly when emerging from the dedicated notch in the base of the case.**

# PENGUIN POWER

**CHANGING PRONOUN** from the *Maximum PC* "we" to the personal "I" for a sentence, this machine marks a proud moment. It's the neatest PC I have ever built and, after only a tiny bit of troubleshooting—one forgotten front panel connector—it ran perfectly. Well, mostly. We'll come to that. NZXT's H400i is so well designed it almost generates its own logic; once it's stripped and clear, an easy process with only a little screwdriver-slinging, it all but invites you to build your PC right.

Not that we did exactly. There were missteps—10 minutes fighting to screw in the M.2 SSD after forgetting to add its tiny standoff to the mobo, and placing the milky white case side on a not-so-clean surface—and there are a few things we'd do differently if we were to do it all again. The fans, for example, each connect to their own extension cables, but the H400i's integrated fan controller cables would have reached them directly. Cable combs might have made the motherboard's 24-pin power connector less tentacly and more uniform. Doubling the build time to route the cables neatly around the back would have been mentally pleasing, but quite unnecessary.

We've yet to work out why we've been unable to initialize the M.2 drive on board, but it's seen in the BIOS and in Windows, so it's probably ridiculously simple. Aside from that, performance is spectacular for a machine of this price, and it's cool and quiet, even when taking a hammering. Partly, that's down to the CPU. When it first dropped, we half ignored its potential, but the four-core Core i3-8350K pulls off solid rendering performance, solid gaming, solid everything, all at a price that redefines the low end. It's unlocked, so we could clock it up even higher if push came to shove—the massive amount of cooling we've built into the case will take care of it, and the extensive reservoir of excess power in the RM750x PSU means we're more than ready for chips with a higher TDP, or a fatter GPU.

Benchmark results, if anything, were a touch higher than we were expecting on the CPU side, and about where we'd thought they would land on the GPU side. While, of course, they lag behind the numbers of the R9 Fury X in our zero-point box—quelle surprise—that GeForce GTX 1060 out of context is no slouch, and it's a good entry level choice that will keep you going (at its level) until you're ready to invest in one of its heavier siblings. Perhaps, were we to do this build again, we would invest a little less in a storage solution that we couldn't get to work, and more in a 1070, or even a 1070 Ti—just as long as we could find a white one, that is.

## BENCHMARKS

| | ZERO-POINT | |
|---|---|---|
| Cinebench R15 Multi-Thread | 987 | 672 (-32%) |
| Cinebench R15 Single-Thread | 196 | 174 (-11%) |
| TechARP's X264 HD 5.0.1 (fps) | 21.93 | 15.94 (-27%) |
| CrystalDisk QD32 Sequential Read (MB/s) | 1,895 | 549 (-71%) |
| CrystalDisk QD32 Sequential Write (MB/s) | 949 | 519 (-45%) |
| Rise of the Tomb Raider (fps) | 41 | 41 (0%) |
| The Division (fps) | 78 | 60 (-23%) |
| 3DMark: Fire Strike (Index) | 15,026 | 10,502 (-30%) |

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM.
All games are tested at 1080p on max settings, with HD texture packages installed.

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# REVIEWS

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ACER ET430K
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# Intel Core i9-7960X

## Core clock versus core count

**WE KNOW FOR A FACT** that the best consumer processor money can buy right now is Intel's Core i9-7980XE. Its 18 cores of brutality lay waste to most, if not all, multithreaded tasks you can throw its way. And single-core? Well, it's enough to make most of the four-core mainstream "gaming" parts weep. If budget is no issue, it truly is the processor to have. In the real world, however, budgets exist, money matters, and even the most foolhardy of content creators would find it hard to disregard the advantages of investing in AMD's Threadripper platform instead. OK, the performance is a little sluggish, and there are issues in some titles, but the fact is, it's almost half the price of its Intel counterparts, making it stunningly good in the bang for your buck stakes.

So, how about the Core i9 featured here? It comes in at a not-so-subtle $1,700, with 16 cores, 32 threads, 22MB of cache, and a base clock of 2.8GHz, turboing up to 3.6GHz across all cores. A meager $300 cheaper than its 18-cored flagship counterpart. However, that one clocks in at 2.6GHz, turboing up to 3.4GHz, which could be a deal-breaker.

This is where things get interesting. Our Core i9-7960X actually beat the 7980XE in two of our benchmarks, even after retesting. Both Fry Render and our X265 benchmark showed small gains for the 16-cored part compared to its older brother. The reason for this seems to lie with two things. One, how Intel is managing those clock speeds. And two, the silicon lottery. When we first benchmarked our Core i9-7980XE, we noticed that small marginal overclocks lead to massive increases in overall performance. If we combine that knowledge with how some of our benchmarks prefer higher overall clock speeds, it suddenly becomes much clearer as to how a 0.2GHz increase across 16 cores could potentially supplant the higher-specced rival in certain use cases. On top of that, our 16-core sample is, by far, one of the best processors we've ever seen for overclocking.

We managed to achieve a staggering 4.5GHz stable overclock across all 16 cores, cooled by a dual 280mm AIO, and nothing more. There was no delidding here, no new BIOS, it just outright held its own with a higher clock, plus lower temps than we've seen from either the 18-core or the 10-core we've tested so far. Given a suitable delid, and some ample cooling on the VRMs, we'd be surprised if this wasn't capable of hitting 4.7GHz, although the power draw on that would be phenomenal.

But the big question is: How does it compare against the might of AMD's 16-core TR4 part, the Threadripper 1950X? Answer: It's damn close. AMD's Ryzen architecture may not have the single-core clout we were hoping for, but its modular design and infinite scalability just go to show how easy it is for the 16-core AMD behemoth to keep pace with Intel's top dogs. On average, we saw around 10 percent less performance from the 1950X compared to the Core i9-7960X. It's a sizable figure, for sure, but if you combine that with the knowledge that it costs almost $750 less than the competition (that's around 44 percent cheaper), well, we'll leave the math to you.

There's no doubt that Intel's Core i9-7960X is a true champ of a high-end desktop part. Its brutal multicore performance, combined with solid single-core might and a well-established platform make it an easy go-to performance part for those looking to maximize their workload with minimum effort. However, it's also a bit of an oddity. It's neither a flagship piece nor is it priced competitively. If you're looking for processors costing over $1,600, you may as well stump up the remaining $400 and grab its 18-core brother, and if you want to save some cash, AMD's Threadripper is your answer. It's good—very good—but we're just not sure it serves much purpose beyond fleshing out Intel's numerical lineup. **–ZAK STOREY**

### BENCHMARKS

| | Intel Core i9-7960X | AMD Threadripper 1950X | Intel Core i9-7980XE |
|---|---|---|---|
| X265 Benchmark (fps) | **42.11** | 38.29 | 41.12 |
| Cinebench R15 Single (Index) | 174 | 167 | **184** |
| Cinebench R15 Multi (Index) | 3,145 | 3,012 | **3,331** |
| Fry Render (Seconds) | **62** | 84 | 64 |
| Total War: Attila (fps) | 40 | 35 | **41** |
| Far Cry Primal (fps) | **77** | 75 | **77** |
| Power Draw Idle (Watts) | 96 | **91** | 95 |
| Power Draw Load (Watts) | **256** | 271 | 261 |
| Maximum Overclock (GHz) | **4.5** | 4.0 | 4.4 |
| Cinebench R15 Multi OC (Index) | 3,873 | 3,448 | **4,284** |

Best scores are in bold. Our test bed consists of an Asus X299 Deluxe (Intel), an Asus ROG Zenith Extreme (AMD), 32GB (4x 8GB) of Corsair Dominator Platinum DDR4, an Nvidia GeForce GTX 1080, and a Samsung 850 Evo 500GB SSD. All games were tested at 1440p on the highest graphical profile.

VERDICT **8**

**Intel Core i9-7960X**

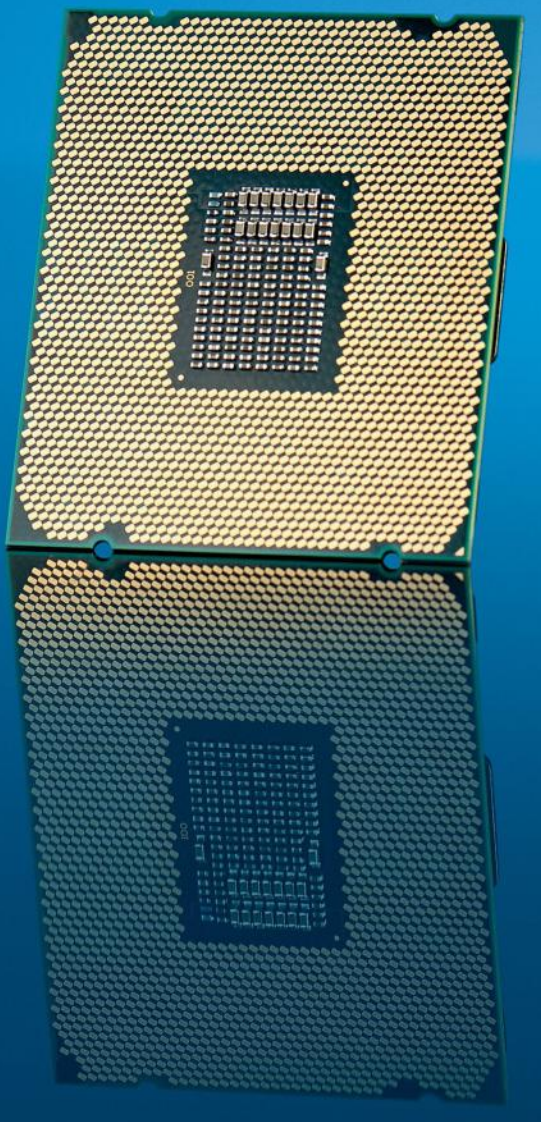
**+ MONSTROUS...** Impressive multicore; stronger in some cases than the 18-core; great potential for overclocking.

**– ...LY BAD** Doesn't fit in the market; price; power draw still phenomenal at OC.

$1,700, www.intel.com

### SPECIFICATIONS

| | |
|---|---|
| Base Clock | 2.8GHz |
| Turbo | 3.6GHz |
| Cores | 16 |
| Threads | 32 |
| Lithography | 14nm |
| Cache | 22MB |
| Memory Support | DDR4-2666 |
| Memory Channels | Quad |
| Max PCIe Lanes | 44 |
| TDP | 165W |



Is Intel's 16-core part the chip to have for the high-end professional?

# Digital Storm Bolt X

## Big is the new small

**WHAT MAKES** a "small form factor" system? Surely massive, hulking machines don't qualify, but is shaving only an inch or two off a standard mid-tower desktop enough to make the cut? That's the question asked by the Bolt X, the latest iteration of Digital Storm's "slim and powerful" small form factor design.

Measuring 15.5 x 6 x 20 inches, and weighing up to 30lb, the Bolt X is only an inch or two smaller than many mid-tower cases, and massive compared to super-compact systems, such as the Corsair One. We wouldn't call it small judging solely from the exterior, but things are different once you look inside. The most impressive achievement of the Bolt X's size is its slimness—at only six inches wide, some finesse is required to fit all the components soundly. That includes a vertical alignment of the graphics card, connected to the mobo by a long ribbon cable.

Speaking of that GPU, it sure is a doozy. The Bolt X is one helluva gaming machine, rocking a single GTX 1080 Ti for pixel-pushing power. It doesn't pack the same punch as crazy high-end dual-GPU builds, but there's also no SLI to worry about. The single GTX 1080 Ti is a powerhouse on its own, pairing nicely with Intel's new i7-8700K Coffee Lake CPU. Both are slotted (the GPU remotely, as we mentioned) into an Asus ROG Strix Z370-I motherboard that also sports 32 gigs of DDR4-3000 RAM.

The first thing we noticed when firing up the Bolt X: Wow, this thing is loud. The CPU fan, a Corsair H115i 280mm Liquid CPU Cooler, was whirring loudly at idle, kicking up to a roar at even the slightest hint of load. The problem was quickly sorted, though, with a tweak to the fan control profile in Corsair Link. Without much ado, the Bolt X was purring along quietly.

So, what kind of power does this compact system pack? Quite a bit. The GTX 1080 Ti crushed our 1080p gaming benchmarks, averaging 167fps in *Rise of the Tomb Raider,* 104fps in *Total War: Warhammer II,* and 74fps in the super-demanding *Ghost Recon: Wildlands.* Those are largely overkill numbers, though, and we wager most users won't be saddling a $3,489 system (yep, the Bolt X is pricey) with a 1080p screen. 1440p is a much more logical companion, and the 1080 Ti performs admirably in that slot.

*Rise of the Tomb Raider's* three-part benchmark served no issue, with the Bolt X scoring 145fps in the Mountain Pass, 110fps in Syria, and 106fps in the Geothermal Valley—an average of 121fps; perfect for a high refresh rate 1440p monitor such as the Asus ROG Swift PG279Q or the Acer Predator XB271HU. *Total War: Warhammer II's* Battle benchmark proved a bit more demanding, but with a score of 74fps, the Bolt X still survived unscathed. The only benchmark to dip below the coveted 60fps line was *Ghost Recon: Wildlands*—but just barely. A score of 59fps there is nothing to scoff at, as that game's Ultra graphics preset brings even the most impressive systems to their knees.

Small or not, the Bolt X brings the might of a full-size gaming powerhouse. And while pricey, it's not nearly as extravagant as some of the pre-builts that have graced these pages. Throw in Digital Storm's top-notch build quality, metallic paint finish, custom cable-sleeving, and did we mention the built-in software-controlled RGB lightshow? X marks the spot. **–BO MOORE**

**BENCHMARKS**

| | ZERO-POINT | |
|---|---|---|
| Cinebench R15 (Index) | 959 | 1,644 (71%) |
| CrystalDisk QD32 Sequential Read (MB/s) | 1,721 | 559 (-68%) |
| CrystalDisk QD32 Sequential Write (MB/s) | 1,473 | 529 (-64%) |
| Rise of the Tomb Raider (Avg fps) | 93 | 121 (30%) |
| Total War: Warhammer II (Avg fps) | 55 | 74 (35%) |
| Tom Clancy's Ghost Recon Wildlands (Avg fps) | 48 | 59 (23%) |
| 3DMark Fire Strike (Index) | 9,128 | 12,863 (41%) |

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point consists of an Intel Core i5-8400, 16GB of DDR4 at 2,666MT/s, an Nvidia GeForce GTX 1080, and a 500GB Samsung 960 Evo PCIe SSD. All games tested at 1440p using highest available preset.

VERDICT **9**

**Digital Storm Bolt X**

**THUNDERSTRUCK** Beautiful presentation; well-designed layout; excellent single-card performance.

**GROUNDED** Large for a "small form factor" system; pricey.

$3,489, www.digitalstorm.com

**SPECIFICATIONS**

| | |
|---|---|
| Processor | Intel Core i7-8700K @ 3.7GHz |
| Graphics | Nvidia GeForce GTX 1080 Ti 11GB |
| RAM | 32GB Digital Storm Performance Series DDR4-3000 |
| Motherboard | Asus ROG Strix Z370-I Gaming |
| Primary Storage | 500GB WD Blue M.2 |
| Additional Storage | 3TB Seagate/Toshiba |
| Cooling Solution | Corsair H115i 280mm Liquid CPU Cooler |
| PSU | 750W Lian-Li PE-750 |
| Case | Digital Storm Bolt X with Storm Blue Exotic paint finish |
| Warranty | Lifetime Expert Care with three-year limited warranty (three-year labor and one-year part replacement) |

The Bolt X isn't the smallest "small form factor" PC, but it sure packs a wallop.

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# Intel Core i3-8350K

## Driving the budget concept in a whole new direction

**THERE ARE TWO** important factors when it comes to Intel's Core i3-8350K: Firstly, it is unlocked, and secondly, it costs $179. It's good that you can overclock it, but that's unquestionably a lot of money for a chip that most of us would perceive as being a budget offering. For context here, this isn't the only eighth generation Core i3 currently available, as the Core i3-8100 rolls in at a much more palatable $117—Intel clearly knows what sort of price it can expect to charge for budget hardware, even if it has decided to ignore that wisdom here.

Pricing aside, it's worth going over what your cash does actually get you. Under Intel's new branding, a Core i3 is a quad-core processor that lacks Hyper-Threading (just like the Core i5), but also lacks a Turbo mode. To be fair, the base clock frequency of 4GHz is healthy enough, even if it won't be jumping up and down as more/fewer cores are used. As we've mentioned, though, this CPU also happens to be unlocked, so if you want to push the chip harder, you can. And you really can.

You get 8MB of cache to help keep things ticking along nicely, support for up to 64GB of DDR4 RAM, and integrated graphics in the form of Intel's UHD Graphics 630, which has a nominal base clock of 350MHz, capable of hitting a maximum speed of 1.15GHz. While this obviously can't compete with dedicated graphics silicon when it comes to driving the very latest games, it does mean that you can build a machine without a discrete GPU, which can help keep the overall price and size of the machine down.

There is one small problem when it comes to that notion of budget, though, and it's that your options on the motherboard front are limited to a single chipset, and that's the enthusiast-class Z370. There is a surprisingly good spread of options here, but with even the cheapest starting out at $115, we're some way off the $70 starting point that formed the basis of many a budget Core i3 build using the B250 mobos from the previous generation. More budget-conscious chipsets should be on the way, but for now, the combo of this chip alongside the cheapest Z370 board starts out at just under $300. Gulp.

### PERFORMANCE PART

We may have reservations about how this chip is being pitched, but when it comes to performance, our opinion is much more straightforward: It's great. That high base clock speed combined with four real cores makes for some great results. Indeed, in testing, this chip was just a shade off the performance offered by the last-generation Core i5-7600K. Here, we've compared it to the closest priced chip from AMD, the Ryzen 5 1500X, which is a quad-core chip as well, albeit with SMT (Simultaneous Multi-Threading), so it can handle eight threads. It's a neck and neck fight, with the added threads of the Ryzen helping it to win in some areas, but the raw grunt from Intel's single-core performance trumping Team Red elsewhere.

When it comes to overclocking, we managed to get our silicon running at 4.9GHz, with only a little extra voltage (1.4V), resulting in a Cinebench score of 784 (with a single-thread score of 205). Impressive figures, even if you will need to spend more on your cooler to hit that.

The real problem for this unlocked Core i3 is Intel's own Core i5-8400, a chip that costs just $8 more, yet boasts 50 percent more cores. The Core i5 also has more cache and a lower TDP, at 65W as opposed to 91W. Of course, you can't overclock that chip, which is a definite win for the Core i3-8350K, but on balance, we'd still prefer to have the extra cores. –ALAN DEXTER

**VERDICT 8**

**Intel Core i3-8350K**

**THRIFTY** Impressive performance; high base frequency; great overclocking potential.

**EXTRAVAGANT** Expensive; lacks Turbo; motherboards are pricey; no cooler; Core i5-8400 is better value.

$179, www.intel.com

### BENCHMARKS

| | Intel Core i3-8350K | AMD Ryzen 5 1500X | Intel Core i5-8400 |
|---|---|---|---|
| X265 Benchmark (fps) | 15.92 | 15.85 | **22.20** |
| Cinebench R15 Single (Index) | **169** | 154 | 165 |
| Cinebench R15 Multi (Index) | 666 | 807 | **949** |
| Fry Render (Seconds) | 352 | 329 | **230** |
| AIDA64 Memory Latency (ns) | **58** | 80 | 69 |
| Total War: Attila (fps) | 40 | 36 | **41** |
| Far Cry Primal (fps) | **77** | 75 | **77** |
| 3DMark: Fire Strike (Index) | **15,725** | 14,528 | 15,405 |
| Power Draw Idle (Watts) | 50 | **42** | 47 |
| Power Draw Load (Watts) | 117 | **101** | 112 |

Best scores are in bold. Our test bed consists of an Asus Maximus X Hero (Intel) or MSI X370 Gaming Pro Carbon (AMD), 16GB (2x 8GB) of Corsair Dominator Platinum DDR4, an Nvidia GeForce GTX 1080, and a Samsung 850 Evo 500GB SSD. All games were tested at 1440p on the highest graphical profile.

### SPECIFICATIONS

| | |
|---|---|
| Base Clock | 4.0GHz |
| Turbo Clock | N/A |
| Cores/Threads | 4/4 |
| Lithography | 14nm+ |
| Cache | 8MB |
| Memory Support | 64GB DDR4-2400 |
| Memory Channels | 2 |
| Max PCIe Lanes | 16 |
| Graphics | Intel UHD Graphics 630 |
| Graphics Clock | 1.15GHz |
| TDP | 91W |

We're only telling you this because we love you.

# Asus TUF Z370-PRO Gaming

## Oh, how the mighty have fallen

**OH, ASUS,** what have you done to our beloved TUF? A brand synonymous with endurance, world firsts, the introduction of dust protection, impeccable cooling, incredible overclocking stability, and a neutral color palette, capable of appeasing even the most accent-phobic of system builders, has been reduced to a budget, entry-level board, daubed with yellow construction-site paint.

As you can probably tell, we were quite fond of TUF. It has powered personal rigs and test benches, and has been a brand that we at *Maximum PC* have always turned to whenever we've needed to construct a no-fuss, get-the-job-done system for any and all. So, when we spotted these new motherboards on the horizon, well, we wept a little on the inside.

Now, let's get this straight: We're not bemoaning the fact that the aesthetics have changed. Although it is a factor, it's not the only reason we're disappointed with where Asus has decided this brand should go. It makes sense, sort of. ROG is there for the gamers, while the WS series is available for professionals with a limitless budget, and the Prime series is aimed at everyone else. So, where does TUF fit into the market? It's arguably a brand that should merge the very best of the WS lineup with that of ROG, with an emphasis on endurance and cooling. OK, so it's not a huge deviation, and traditionally we've always railed against cheapjack rebrands of the same board for more dollar—but this? This is just cruel.

Don't believe us? Then let's bust out the comparison list. So, compared to the previous generation, first and foremost, there's no longer any dust-protecting armor. Secondly, there's no reinforced backplate. Thirdly, there's no USB C rear I/O. Number four: no PCIe SSD covers (or any covers, for that matter). Five: the addition (it's staggering this) of two vertical facing SATA ports. Six: DVI-I out instead of better substantiated I/O. And lastly, the loss of seven PWM fan headers—seven!

Anywho, enough with the railing—let's get back to what matters. And that is, of course, performance. Overall, the Z370-PRO Gaming is a fairly solid all-around board; it performs in a very similar manner to the Maximus X Hero we tested not so long ago, with comparable scores in Cinebench R15, Fry Render, and X265. Latency is slightly improved, thanks to the more modern BIOS, and sequentials seem up as well. On the whole, overclocking was also pretty similar—we didn't encounter much in the way of issues when it came to hitting our 5GHz target. Unfortunately, Asus is still plagued by those ramped-up stock voltages, and it's quite commonplace to see temperatures reach 70 C under load at stock, even with a 280mm cooler, with the trade-off being the additional 10 percent performance.

By all accounts, ignoring its heritage, it is a solid and dependable board in today's market. It's a touch pricier than we'd like ($130–140 would have made more sense), but that aside, it performs just as well as boards twice the price, and we've got to give it credit for that. We just wish there was a premium TUF option out there, at the usual pricing ($260 on launch, typically), as opposed to this cut-down, basic version we've been given. If you're after a budget overclocker, and don't mind the garish yellow paint job and overvolting CPU VCore, though, this fits the bill nicely. **–ZAK STOREY**

### BENCHMARKS

| | Asus TUF Z370-PRO Gaming | Asus ROG Maximus X Hero |
|---|---|---|
| X265 (Avg fps) | **30.68** | 30.65 |
| Cinebench R15 Multi (Index) | 1,536 | **1,553** |
| Fry Render (Seconds) | **133** | **133** |
| AIDA64 Memory Latency (ns) | **47** | 48 |
| Power Draw Idle (Watts) | **64** | 65 |
| Power Draw Load (Watts) | 207 | **198** |
| CrystalDisk Sequential Read (MB/s) | **552** | 532 |
| CrystalDisk Sequential Write (MB/s) | **533** | 501 |
| Far Cry Primal (Avg fps) | **42** | **42** |
| 3DMark: Fire Strike Extreme (Index) | **9,853** | 9,785 |
| Maximum OC Achieved (GHz) | **5.1** | **5.1** |

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB (2x 8GB) of Corsair Dominator Platinum DDR4 3200, an Nvidia GeForce GTX 1080, and a 500 Samsung 850 Evo SSD. *Far Cry Primal* tested on Ultra settings at 4K.

VERDICT **7**

**Asus TUF Z370-PRO Gaming**

**HONOR THE ANCESTORS** Strong performance for the price; good on-board connectivity.

**HONOR THE WHAT?** Poor rear I/O; degradation of a brand; lack of cooling; no premium option; overvolts CPU; nothing to make it unique; color scheme.

$160, www.asus.com

### SPECIFICATIONS

| | |
|---|---|
| **Chipset** | Z370 |
| **Socket** | LGA1151 |
| **Form Factor** | ATX |
| **Memory Support** | 64GB DDR4 @ 4,000MT/s |
| **M.2/U.2 Support** | 2x M.2 PCIe x4 |
| **SATA Support** | 6x SATA 6Gb/s |
| **Max PCIe Support** | 2x PCIe 3.0 x8x8 |
| **Rear I/O** | 1x Intel Gigabit Ethernet, 2x USB 3.1 Type A, 4x USB 3.0, 2x USB 2.0, 1x PS/2 port, 5.1-channel audio, optical out, HDMI out, DVI-I out |

# Acer ET430K

## IPS visuals on a truly epic scale

**IT IS A TRUTH** universally acknowledged that a monitor is the best long-term investment you can make for your PC. Or it used to be. Go back a decade, and the greatest flat panel was Dell's 3007, a 30-inch beast with what was then a monster native resolution of 2560x1600, and a quality IPS panel.

It wasn't cheap. But for the next seven or eight years, little arrived to truly usurp it. Sure, incremental advances were made. But short of spending mega bucks on something really exotic, the 3007 remained a premium experience. That was true until two to three years ago, when the 4K revolution arrived, and suddenly 2560x1600 was old news. Meanwhile, further new features such as adaptive sync, high refresh rates of 120Hz-plus, and HDR tech have upped the ante in terms of image quality beyond mere pixel count.

Does the same logic apply today? Do PC monitors still make good long-term investments? Enter the Acer ET430K. The headline stats involve a full 4K res, thus 3840x2160 pixels spread out across 43 diagonal inches. Critically, it also offers IPS panel technology. In this part of the market, the 40-inch-plus space, it's common to find panels pinched from HDTVs. That often means VA rather than IPS panels.

VA has advantages that map well to HDTV use, including strong contrast and heightened color saturation. The downsides are reduced accuracy, mediocre pixel response, and good, rather than great, viewing angles. Straight out of the box, this new Acer impresses with its sense of control and accuracy. It's not going to worry a true pro panel for accuracy or color space capability, but it feels like a PC monitor, not an over-saturated HDTV in drag.

Detailed impressions of image quality are good, too. The viewing angles are nice and broad, there's plenty of detail in white scales, and gradients are rendered very smoothly. At factory default calibration, there is some mild compression in darker tones, but it's probably only of concern to content creation pros. Likewise, pixel response is acceptable, if not spectacular, and there's little by way of input lag in subjective terms, both of which make the ET430K a decent gaming proposition, so long as you're happy to do so at 60Hz refresh rate. The response and silky-smooth thrills of 120Hz-plus are not available here.

If there is a visual demerit to note, it involves a difficult to describe form of panel interference, in which large elements on the screen create visible vertical artefacts above and below. The ET430K only suffers very slightly from this. It's much more apparent on some older panels in the 40-inch-plus 4K class. For the record, while we're talking 40-inch monitors, you won't notice the difference in terms of the pixel pitch of this 43-inch model versus 40-inch 4K monitors. The pixels here are indeed slightly larger on paper, and for those who appreciate the crispness that comes from tight pixel pitches, that's a worry. In practice, it won't bother you.

Factor in some nice industrial design, including slim bezels and understated but polished styling, and you have a very strong package. Admittedly, it's unlikely to stand the test of time like that old Dell. It won't be long before 4K plus 120Hz refresh becomes widely available. 8K resolutions aren't far off, either. But at sub-$600, the ET430K is actually relatively affordable. So, Acer's new 43-inch effort might not quite make for a decade-long investment, but it's probably one of the best big-format 4K monitors on the market for anything close to this kind of money. **–JEREMY LAIRD**

VERDICT
9
KICK ASS!

**Acer ET430K**

**+ MARILYN MONROE** Big, beautiful IPS panel quality; full 4K resolution; competitively priced for large 4K monitor.

**– SEVEN YEAR ITCH** "Only" 60Hz; pixel pitch and response times merely adequate.

$565, www.acer.com

### SPECIFICATIONS

| | |
|---|---|
| **Panel Size** | 43-inch |
| **Native Resolution** | 3840x2160 |
| **Pixel Density** | 102 |
| **Panel Type** | IPS |
| **Maximum Refresh** | 60Hz |
| **Response** | 5ms |
| **Contrast** | 1,000:1 |
| **Display Inputs** | HDMI, DisplayPort, Mini DisplayPort |
| **Connectivity** | None |
| **VESA Mount** | 100 x 100mm |
| **Warranty** | Two years |

Acer's new 43-inch screen combines 4K visuals with IPS panel quality.

Future

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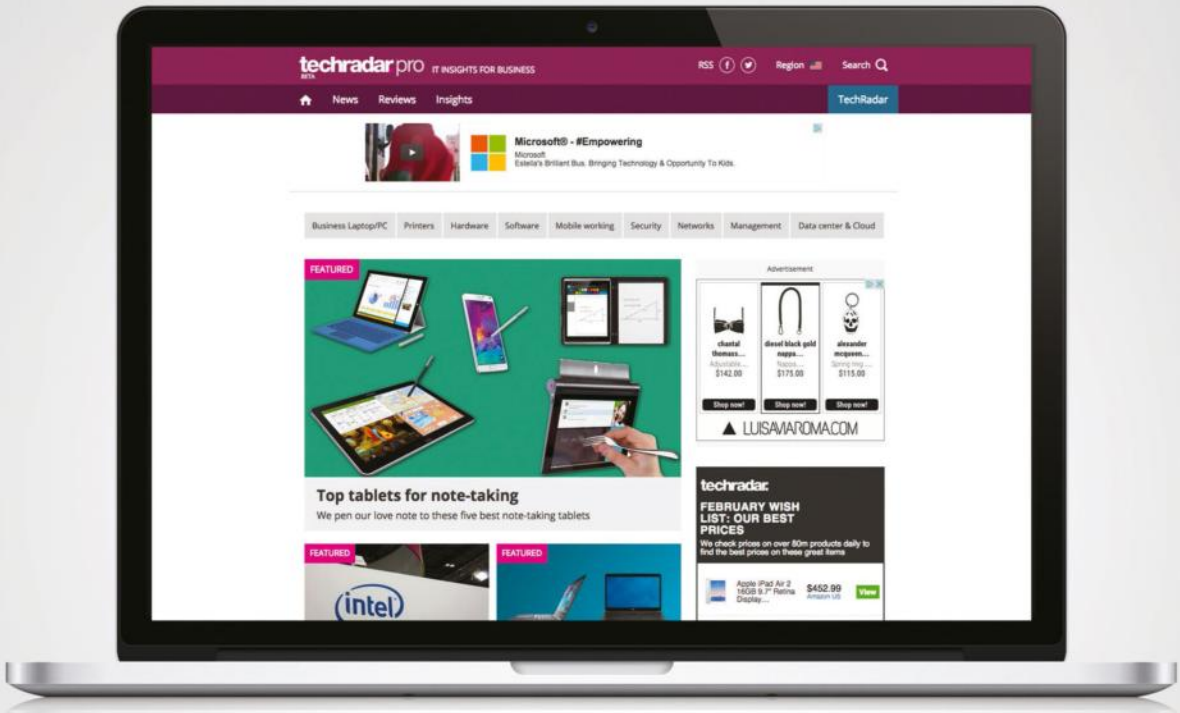
## IT INSIGHTS FOR BUSINESS

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# Logitech G231

## Just because you can, doesn't mean you should

**LOGITECH HAS ALWAYS BEEN** one of the true champions of the PC peripheral market. And with a market cap of $5.75 billion, it's not hard to see how well it has done over the years. From joysticks to mice, keyboards, headsets, and more, the company has practically defined the gaming peripheral industry. Whether it was through the near-mythical G15 LCD-displaying illuminated keyboard, or the ambidextrous genius of the G5 mouse, Logitech has earned itself a legacy against which very few others can compete.

You'd expect, then, that most, if not all, of its products would be of a higher caliber than the average joe's. Surely, wherever your budget falls on the grand peripheral spectrum of purchasing power, Logitech's offerings, with its prestigious history of world firsts and fantastic design solutions, would trump the rest? Sadly not, and here we have a prime example of when things don't go quite right.

Simply put, we cannot recommend the G231 headset. Let's start with the good: From a distance, it looks great. And now the bad (yup, it really is that bad). The biggest problems lie with the construction of the headset, as the materials used are particularly coarse, and the clarity (or lack thereof, in this case) found within the drivers themselves.

When it comes to music, the G231 lacks any definition in the upper end of the treble. The muffled cries of artists feel hidden, almost smothered by the dominating thrum of overpowering bass notes. Definition of sound is lost for the sake of gaming prowess and awe, if you can call it that. Sure, having the ass-end of most soundscapes weighted down does add drama to the often-explosive scenes embedded into the latest AAA titles. But when you're struggling to hear a gun cock, or the voice of a character make its way to the front of a furious foray, you have to ask yourself, who exactly thought that designing a driver like this, so heavily saturated by those emphatically heavy brown notes, was such a good idea? And then there's the issue of design quality. Credit where credit's due: As a whole, the design isn't actually too bad. It follows Logitech's somewhat meticulous styling, rather akin to some form of futuristic military aesthetic, with sharp lines following through a very squared design. The problem, however, is the materials employed. The plastic feels similar to that used to make a young child's toy, with a soft sheen and a sense of snappability under your finger. It certainly doesn't feel as though it could take much in the way of strain. Couple that with a very similar feeling microphone boom mechanism, and the G231 simply doesn't sing itself any praises.

That bad, then? Well, yeah. We're not just saying this because we're used to all manner of weird and wonderful triple-digit priced cans, but because it doesn't even hit the mark compared to products at the same price point. Take SteelSeries's Siberia 150, for instance. It comes in a few dollars cheaper, yet the contrast between the two couldn't be more apparent.

The Siberia 150's soundscape is clean, refined, with no heavy emphasis on bass. We're not talking HyperX Cloud quality, but it's acceptable given the $49 price tag. There's less material there, too, but what there is feels flexible and strong, and the more abrasive finish on the headband feels more premium. What we will say is that if all you're after is a headset purely for gaming, and your budget is at the tighter end, the Logitech G231 is fit for purpose. It's not the best, but it does the job. For anyone who delves into the world of music, film, or anything else, you really should look elsewhere. –ZAK STOREY

VERDICT **5**

**Logitech G231**

**OH EM GEE** Huge bass footprint; stylized design.

**JEEZ...** Poor driver clarity; flimsy materials; boom arm mechanism; ugly finish.

$53, www.logitech.com

### SPECIFICATIONS

| | |
|---|---|
| **Driver Type** | 40mm dynamic |
| **Impedance** | 32 ohms |
| **Frequency Response** | 20Hz–20kHz |
| **Design Style** | Closed back |
| **Microphone Type** | Cardioid |
| **Connectivity** | Analog 3.5mm |
| **Weight** | 0.6lb |
| **Cord Length** | 6.5 feet |

# Razer Lancehead

## Can it convert the cynics?

**RAZER IS ONE** of those brands you either love or hate. For most, the snake-headed emblem is one to be admired. After all, the company has produced some legendary products over the last decade. From clicky green mechanical (non-Cherry) switches, to the stunning Deathadder, the brand has helped shape and refine exactly what the PC gaming genre is all about. However, not everything it has produced has been a success, and for some (this journalist included), not everything has hit the mark.

Mice are hugely subjective peripherals, depending entirely on the human at the other end of them. Ultimately, it always falls down to two things: how large your hands are, and how you use the mouse. From claw grips to palm grips, and large meat hooks to small dainty pinky pickers, the variance in style and shape means it's near impossible to find a mouse that covers all bases proficiently.

Typically, Razer usually caters for the larger handed man and woman, with a mouse style that favors the claw grip over the palm-handling alternative. Believe us when we say, then, that the Lancehead, in its reptilian named fashion, looks toward the other end of that spectrum, and has converted us to the house of Razer. Much like the snake it takes its name from, its subtle looks and stylized ambidextrous design has absolutely hit the mark. Designed for those with a fondness for the palm grip, yet still harboring the potency of any other Razer mouse, it's worthy of much admiration.

Like most high-end Razer products, there are two separate variants of the Lancehead mouse: your standard, premium affair, packing a 24-hour wireless battery life, and a more standardized cabled Tournament Edition. The theory being that if you wish to be free from the tyranny of cables, you can choose the wireless edition, otherwise the TE version should meet your needs.

The thing is, the price difference between the pair of them is an incredible 60 bucks. Yet, spec for spec, the two mice are almost identical, with the only difference being (aside from the connection standard, of course) that the Tournament Edition is 0.16oz lighter than its wireless counterpart. Staggering, right? Both use the same sensor, boast the same bespoke mechanical switches, and feature the same RGB lighting.

### DOWN TO THE WIRE

On top of all that, the TE Lancehead is available in white, black, gray, and a shocking pink. Choices galore. So, is it worth stumping up the extra $60 just for the addition of wireless? Wireless that lacks a dock to charge overnight, at that, and only manages a 24-hour battery life? We are not convinced.

The Lancehead is, by and large, a fantastic solution for anyone looking to get a more premium feel out of Razer's mouse lineup. The finish on it is exceptionally smooth and soft to the touch, yet without the rubber smudge coating that we find on most mice. Not only that, but the laser sensor is sharp and crisp, as far as we can tell—although, to be frank, you would struggle to find a bad sensor nowadays anyway, unless you're at the absolute cutting edge of fps gaming.

So, this is a bit of a weird position for us to be in. For the first time in a review of a product, we're actually commending and recommending the wireless variant's little brother, the Lancehead Tournament Edition, instead of the one we're actually reviewing. Ultimately, you really, really, really have to love wireless to buy the full-fledged Lancehead, and, to be honest, we're still not totally sold on it. Sure, not having a cable is a pretty sweet luxury, but needing to charge it up on a daily basis, and mess about plugging in another cable, well, it's just asking for trouble. Lancehead, we're sorry—it's not you, it's the wireless. –ZAK STOREY

**VERDICT 7**

**Razer Lancehead**

**ANTIVENOM** Stunning design; ambidextrous; strong sensor; fantastic finish; good lighting; nice weight.

**ANTACID** Wireless still flawed; huge price hike; less color choice.

$140, www.razerzone.com

**SPECIFICATIONS**

| | |
|---|---|
| **Sensor** | Laser |
| **Sensitivity** | 16,000 dpi |
| **Sensor Model** | Razer 5g Laser |
| **Polling Rate** | 1,000Hz |
| **Programmable Buttons** | 9 |
| **LEDs** | Tri-zone, 16.8 million colors |
| **Battery Life** | 24 hours |
| **Cable Length** | 7 feet |
| **Weight** | 3.8oz |

# BitFenix Enso

## When RGB is life

**THERE'S A FACETIOUS** argument going around the tech industry that says RGB sells, therefore more RGB must be added to more products. From GPUs to motherboards, and memory to mouse pads, we've seen it on everything. The problem we have with that argument is that if anything over 50 percent of the products out there feature RGB, then of course RGB is going to sell more. It doesn't necessarily mean that it's more popular, just that you have more RGB products than non-RGB. And as a consumer, if you're left with just one choice, what other option is there?

BitFenix's Enso looks to capitalize on that growing "demand" for all the red, green, and blue, with what can only be described as the world's most boisterously disorderly LED-lit chassis. Featuring four individual LED RGB strips baked into the corners of the front panel, each vertex glows with an incandescent rainbow wave, for those who desire it, or full individual colors if you're after the thematic color-matching look instead. There's no software control here, but instead a single button is located on the front I/O to cycle through all the lighting effects.

Although RGB cases are few and far between, we have seen similar features in the past. Typically, however, these only extend as far as an individually lit logo or power button, not a fully lit wavy design embedded into the front of the case. You're either going to love it or hate it, and for those who love it, it's going to be a welcome addition to an already extensive customization option. For the latter? Well, this probably isn't the case for you.

Lighting aside, the Enso is adequately priced and nicely equipped. For an affordable $85, you net yourself a mid-sized ATX tower, packing all of that RGB, a tempered glass side panel, a PSU cover, SSD mounts, and plenty of cable management. On top of that, there's some smart slide-out fan filters included on the right-hand side, as well as a magnetic soft-touch dust cover, or mesh filter, for the top two 120mm fan mounts.

The Enso is, however, not without its problems. And there are two that immediately detract from the otherwise brilliant composition that an illumination enthusiast might appreciate. By far the biggest is airflow. The front of the chassis lacks any major source of air intake, with only scant access being available from a small two-inch cutout situated at the bottom of the front panel that draws air in from the back of the chassis, funneled through two channels around the feet.

In today's age of hot-headed processors, the inclusion of some form of mesh intakes along the edges of the front panel (as seen on the H700i, for instance) would help alleviate these worries considerably. Unfortunately, that single two-inch cutout just isn't enough to ensure the front fans (of which you can mount two 140mm) are adequately fed with enough air to keep your internal bits and bobs cool.

Then there are the materials used. There's just too much plastic and steel for our liking. Sure, you get yourself a lovely tempered glass window and some smart lighting, but when you consider that Phanteks provides both of those in its Eclipse P300 for almost $25 less, you have to ask what you're actually paying for. There's no soft-touch finish, no premium coating—everything has been thrown under the bus in order to hit that $85 price point and show off the LED innovations embedded within.

If this came with a single white LED, better airflow in the front, and a premium finish at the same price, we could get behind it. Unfortunately, as it is, unless you live in Fargo, North Dakota, and really love wavy illuminations, this chassis is probably best ignored. –ZAK STOREY

**VERDICT** 7

**BitFenix Enso**

**SUPERNOVA** Well equipped; adequate price; RGB lovers will enjoy it.

**BLACK HOLE** Awful cooling; cheap materials; RGB lighting before all else.

$85, www.bitfenix.com

### SPECIFICATIONS

| | |
|---|---|
| **Form Factor** | Mid-tower |
| **Motherboard Support** | E-ATX, ATX, microATX, Mini-ITX |
| **Colors Available** | Black, white |
| **Window Available** | Yes |
| **3.5-Inch Support** | 2 |
| **2.5-Inch Support** | 3 |
| **Fan Support** | 2x 140/120mm front, 2x 120mm roof, 1x 120mm rear |
| **Radiator Support** | 280mm front, 120mm rear |
| **Dimensions** | 8.3 x 19.3 x 17.9 inches |
| **Graphics Card Clearance** | 13.38 inches |
| **CPU Tower Clearance** | 6.29 inches |
| **Weight** | 15.4lb |

It wouldn't be *Call of Duty* without vehicles and mounted gun sections.

# Call of Duty: World War II

## Proof that you can teach an old COD new tricks

**WAR, IT SEEMS,** changes on an annual basis, and sometimes comes full circle. The decision to return to World War II was controversial, but a reboot could help revitalize a series that's been looking a bit tired, if not lacking in imagination, across its most recent installments. Single-player is treated less as training for multiplayer this time, and benefits hugely from it.

Here we have war divided into 45-minute packages, in which huge events are thrown away, and drama is found in the small moments that matter to one or two lives, rather than hundreds. The game's opening is the D-Day beach landings, yet it's swiftly dealt with in favor of clearing bunkers. This may be a wise decision, as while the amphibious invasion was a turning point for the war, it's become familiar from constant exposure in games, TV, movies.

So, while we get a bit of shaking and roaring, running between cover and getting repeatedly shot by machine gunners we can't see, one blast through a wall and it's into the bunkers. This is where *COD: WWII's* smaller scale asserts itself. Much of the game is about five guys being buddies against a backdrop of horror, and you're tied to your pals as they keep you supplied with ammo and health packs (which, *Medal of Honor*-style, require a few seconds in cover to top up your non-recharging health bar), as well as spotting enemies, and calling in mortar strikes. Each of these abilities is tied to a cool-down timer, and each squadmate can only do one thing—so finding the right one in the heat of battle is essential.

It's an artificial-feeling system—though no more so than *Black Ops'* invisible cyborgs, and we rarely needed to ask for ammo, as there are plenty of German guns laying around, as well as universal refill chests—but it underlines the friendships that are formed in battle, and means when one gets wounded, you feel it all the sharper. There are peripheral characters as well: gruff officers and little girls to rescue, and the player character's brother seen only in flashback. *COD: WWII* works hard to make you care, slipping in Heroic Actions, in which you rescue allies, drag wounded to safety, and the like. This presentation of war as a series of small dramas is effective, and a nice contrast to the epic presentations of conflict we've seen previously.

So, *COD: WWII* is earnest and respectful, and tries to be historically accurate, then there are Nazi zombies. The horror-tinged co-op wave defense mode has more flesh on its bones, with a cast of recognizable names, and that this apparently throwaway mode has been treated this way is indicative of the level of care lavished on the game. The expansive multiplayer benefits from the new old setting in terms of atmosphere and intimacy (set someone on fire for really intimate sound effects), but the lack of mobility caused by soldiers who can't literally fly means this is a return to the days of twitch kills and death from someone you've not seen. But the guns have heft, and their bullets hit hard, something that can be said of every mode, so there's great satisfaction to be had from the blasting.

A new *Call of Duty* is always an event—however, despite producing the best campaign in years, backed up by a bulging package of multiplayer and zombies, the rest of the industry has moved on. There are better playgrounds in which to shoot Nazis these days. **–IAN EVENDEN**

VERDICT **7**

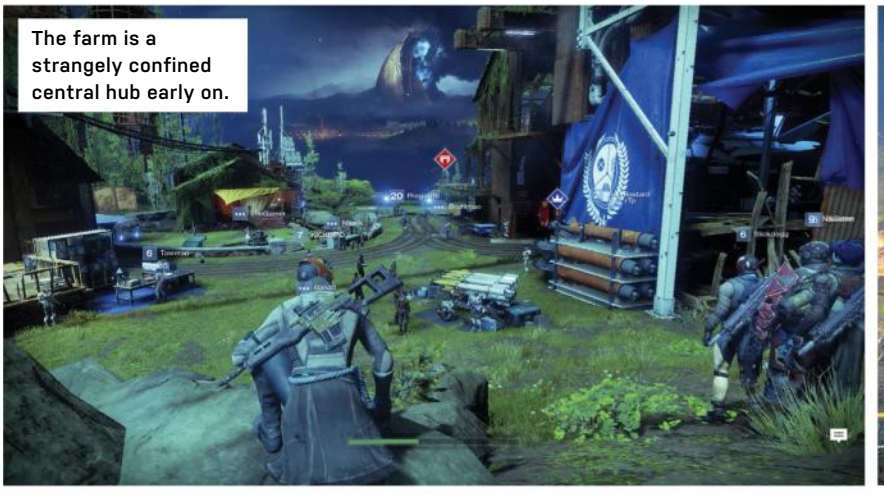
**Call of Duty: World War II**

**WARFARE** Gritty, detailed look; well-composed campaign.

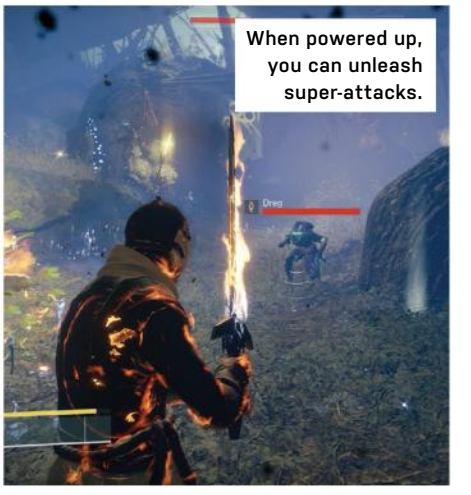
**WELFARE** Can be very brown and gray; other games have already surpassed it.

**RECOMMENDED SPECS** Core i3-3225 3.3GHz or Ryzen 5 1400, 8GB, GTX 660 or RX 550 with 2GB of VRAM, or better.

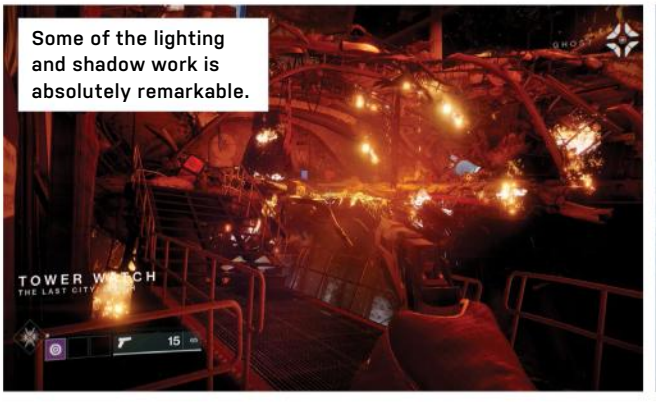
$60, www.callofduty.com, ESRB: M



The farm is a strangely confined central hub early on.



When powered up, you can unleash super-attacks.



Some of the lighting and shadow work is absolutely remarkable.

Bungie is never afraid to keep interesting things in the distance.

# Destiny 2

## The world may be over, but you still have your buddies

**ONE OF THE BEST GAMES** never to come to PC, *Destiny* captivated console gamers as they repeated the same few co-op missions, plus a PvP arena, in search of slightly better guns and armor, handed out with a strong dose of random number generation.

*Destiny 2* picks up where the first left off, but if you haven't played it, that doesn't matter. There's enough of a recap, and it's all nonsense anyway. A giant baseball came to Earth, and made everything groovy, only for aliens to show up, and start a war. Now Earth is down to one city, and it's up to Guardians—that's you, and there's a lot of you—to defend it. However, in an unusual twist, the aliens won, the source of your powers—Light—was removed, and the remaining Guardians are holed up on a farm in the cheerily titled European Dead Zone. And, of course, you find more Light.

*Destiny's* hook is its seamless spanning of single- and multiplayer. Story missions and Patrols can be played alone, Strikes need three, and Raids require six—the biggest of them asking for tight communication and planning. But despite coming through Blizzard's Battle.net, this is a Bungie game, and Bungie made *Halo*. So you get a huge dose of gun fetishization, each presented as much as a bundle of stats as it is a shooting machine. Damage numbers fly off targets to underline weapon differences, and the chunky weapon models buck and kick.

Outside of guns, the game is beautiful, and sounds amazing, too. Environments gleam, the lighting a masterclass in its art, and the camera clever enough to linger on long-range vistas. Skies, in particular, are worth dwelling on, while the soundtrack swells and intensifies with the action. Your character's walk is a slow, purposeful one, and once you're able to use Light, the feeling is one of controlling a colossal badass.

Badasses come in three races, can carry three guns, and there are three classes. You are sorted into a sub-class, and continue to improve your character as it gains XP and levels up, unlocking new skills and attacks, as well as reducing cool-down timers.

None of this, however, can mask the repetitive nature of the proceedings, as you fight many of the same enemies (who even come through portals and from dropships to harass you as you're walking around hub areas) in the same ways (shoot through a cloud of grunts to reach a shielded captain who you must defeat to get the loot chest he's sitting on). Strikes and Raids are the core of the game, with the Crucible arena a way of displaying your skills—player stats are balanced out—in teams of four. And it's this co-op nature that sets *Destiny* apart, that makes the repetition acceptable. After all, it's not really repetitive if you improve every time, and finally get a slightly better gun on the sixth try, is it? **–IAN EVENDEN**

VERDICT **8**

**Destiny 2**

**DESTINY** Lush visuals and sound; constant loot crawl.

**DENSITY** Repetitive nature; paid-for expansions already available.

**RECOMMENDED SPECS** Core i5-7400 3.5GHz or Ryzen 5 1600X 3.6GHz, 8GB, GeForce GTX 970 or AMD R9 390.

$60, www.destinythegame.com, ESRB: T

# LAB NOTES

**ZAK STOREY**, DEPUTY EDITOR

## A Somber Tone

### Facing the big black dog

**THE BIG BLACK DOG**—many of us have faced it. That nasty feeling at the back of your mind; that weight on your shoulders, sucking the energy, charisma, and lifeblood from you. Everything that made you human feels like a distant memory, as you parade around your life, a shell of who you once were, pretending everything's fine.

Depression is one of the toughest things most of us will ever battle. Yet it still faces stigma even today. It's simply not spoken about, nor even acknowledged by many. The thing is, life and its experiences are subjective, different according to the individual going through them—pain, struggles, emotions, they're all unique to you. Some people are mentally stronger than others, and can cope with stress; others are less able. Unfortunately, there is no easy solution, no simple cure-all. Each of us will have a different battle to face, and each has to find a different way to succeed.

For me—and this is going to sound insane, given what I do for a living—the best way to focus myself is to step away from the PC. There's no doubt that gaming and tinkering do help alleviate some of the stresses I face each day, yet the more I sit glued to a screen, the bigger that black dog becomes. Getting outside, away from technology, noticing the world around me, and pushing myself physically is the key to my happiness.

Over the years, I've learnt that the dog isn't my enemy, but a companion. It's made me who I am, and is something I'll likely live with for the rest of my life, so knowing how to keep it in check is paramount to my well-being. Sometimes, getting away from the rig is the best thing you can do, at least until your mind is back in check.

**Sometimes, all you need to do is step away from your PC for a while.**

## JARRED WALTON

**Senior Editor**

Samsung, Micron, and SK Hynix all have GDDR6 plans for the coming year, with speeds of up to 16Gb/s. GDDR5X officially tops out at 12Gb/s, so GDDR6 provides up to 33 percent more bandwidth, and double that of GDDR5. HBM2 packs more bandwidth into a smaller area, but the costs of HBM2 are substantial. We'll likely see plenty of new GPUs this year that skip the silicon interposer of HBM2, and opt for GDDR6. I suspect Nvidia will go with GDDR6/5 on the GeForce Volta products, while AMD may have some lower tier Vega cards that opt for GDDR6. Navi, on the other hand, will probably go with HBM2—assuming that AMD's partners can get 7nm ready in time for a 2018 release.

## ALAN DEXTER

**Executive Editor**

When even not-very-tech-savvy family members start asking you what the next big cryptocurrency is going to be, you know that last year's rise (and subsequent fall) in Bitcoin hasn't gone unnoticed. Unfortunately, there are no easy answers when it comes to sure-fire investment tips, as no one really knows what the next big thing is going to be. The Internet is awash with "experts" claiming to predict the future, but they're educated guesses at best. There are plenty of technical reasons why Bitcoin won't be the coin that finally makes the cut, but that hasn't stopped its incredible rise. My advice? Don't gamble (or invest) what you can't afford to lose. Especially with crypto.

# Editors' Picks:
# Digital Discoveries

Bo Moore, technology editor, and Tuan Nguyen, editor-in-chief, share their recent technology loves

### RAZER MEKA

When I'm not reviewing laptops, I spend a good bit of time battling it out with the heroes of *Overwatch*. I don't usually go all fanboy on game-branded toys or peripherals, but something about *Overwatch* just tickles the right nerves for me, so when Razer announced this rad pair of *Overwatch*-themed headphones at BlizzCon 2017, I knew I needed them.

Modeled after the headphones used by in-universe professional *StarCraft* player turned MEKA pilot turned *Overwatch* hero Hana "D.Va" Song, these MEKA-themed headphones help me feel like the world-defending hero I know I am. Sure, the sound isn't audiophile quality, but with 40mm Neodymium drivers and leatherette ear cups, they're more than enough to get me through a lengthy gaming session.

For extra D.Va flair, Razer also has a Goliathus oversized mouse mat and Abyssus Elite 7,200 dpi gaming mouse—in honor of D.Va's *StarCraft* roots—tricked out with D.Va's pink and blue paint scheme. They're nice additions to the arsenal, but it's D.Va's headset I'm really psyched about. Colors are one thing, specially modeled headphones are another. I had to have them. GG.
$80, www.razerzone.com

### MICROSOFT CLASSIC INTELLIMOUSE

I admit: I got excited about a mouse. But it's not just any mouse, it's the mouse that made the modern mouse. The original Microsoft IntelliMouse was one of the most popular pointing devices in its day, and it continues to impact mice with its ergonomic design.

Which is why I ordered the new Microsoft IntelliMouse Classic. It's an update of the IntelliMouse Explorer, with bumped-up specs for more precise tracking. The original even sported a red glow. Thinking about it, I suppose Microsoft was responsible for starting the LED-lit accessory trend. While the new IntelliMouse Classic doesn't go all-in with RGB lighting, it does update the original with a white glow under the base, and a small monotone Windows logo.

Microsoft says its new critter uses BlueTrack for tracking, and enables you to use the mouse even on glass, but I still recommend some type of mousing surface.

I always wondered why Microsoft didn't continue updating its excellent IntelliMouse; now the wonder is over. The company doesn't make a huge range of PC accessories, but what it does produce has been mostly high quality and durable. I still have the original IntelliMouse, and it still works.
$40, www.microsoft.com

GEEK TESTED & APPROVED

## Schiit Modi 2 Uber & Magni

**WE FINALLY GOT** in some good Schiit. I've been working on plans for a new desk, and ever since having to hand back my Denon DA-300USB DAC, my heart has been pining for a suitable external audio solution. Since the main man, Tuan, has been talking Schiit to me for the last year or so, I figured it was only right I put down some of my hard-earned cash on a doozy of a budget audiophile combo: the Schiit Modi 2 Uber DAC and Magni headphone amp, a small, svelte combination of HRA (High Resolution Audio) awesomeness. Each comes in at a more than affordable $99, with a luscious aluminum chassis, and a teeny form factor. The devices are stackable, measure 5 x 3.5 inches, and as a combo, they're fantastic.

The Modi 2 Uber has inputs for USB, optical, or analog, and outputs via a single left and right channel coaxial, so you need to pump it into something else. In my case, that's the Magni headphone amp. With a 0.25-inch headphone jack out, and additional coaxial out, it's the perfect choice for the Modi, a pair of cans, and some studio monitors.

Overall, the sound quality is good, distortion is minimal, and everything (particularly HRA) feels incredible, especially at the price. I'm following through with a pair of Audiotechnica ATH-2000Z headphones.

So, back to the desk. Well, the plan is to mount the pair on the underside of the desk, sitting in a special metal caddy. It's a bit overkill, given their size, but it'll look damn good, and adds that extra premium audio element we need to our professional editing desk of choice. **–ZS**
$198, www.schiit.com

# LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

## > Annoying Antivirus
## > Mobo Woes and Worries
## > Grid References

### Antivirus Agonies

What I need now for my PC is an anti-antivirus program that keeps programs like Malwarebytes and Norton Security from popping ads trying to sell you stuff in the lower-right corner of the screen. Somebody should explain to these vendors that their ads defeat the whole purpose of having their programs. That's what they're supposed to be protecting us from, instead of being the culprits themselves. Why pay for the programs if they're going to do that? **–David Brumley**

**EXECUTIVE EDITOR ALAN DEXTER RESPONDS:** If the tools in question were free and helped cover their development costs with advertising, we could at least understand why this was happening, even if we still wouldn't condone it. The fact that you have paid for them and they're still producing pop-ups has us recommending that you uninstall them. But that may be a bit hasty, as a quick search suggests there was a problem with Norton Security producing more pop-ups than it was supposed to, and an update should have fixed this; so we suggest dropping Symantec a line, because it shouldn't be doing this. Do the same with Malwarebytes, and if you're still getting ads, look for alternatives.

**Most of Asus's X399-A mobos support M.2 solid-state drives.**

### Motherboard Help

After reading *Maximum PC* for a number of years now, I feel I am ready to build my next PC myself. The biggest area of concern for me is the motherboard. Getting everything plugged in and working correctly is still a bit over my head.

Going forward, I would be looking for guidance and videos online regarding setting the motherboard up and connecting everything. There are plenty of how-to type articles out there, but a lot of the time, they instruct you to read the manual first, and just follow what that says to do. RTFM, as they say.

My question is: Who do you think makes the best set of instructions or manuals for motherboards? Right now, I am thinking I may go with Asus or MSI. My current motherboard is a Gigabyte one; it's a good board, don't get me wrong, I just found it lacking in the way of having an easily understandable UEFI/BIOS and manual.

**–David Schowalter**

**EXECUTIVE EDITOR ALAN DEXTER RESPONDS:** The good news is that there isn't an awful lot to plug into a motherboard these days—possibly the trickiest thing is sorting out the connectors from your case, and even that isn't too difficult once you've found the right block of pins. The motherboard manual is indeed your handy guide for such things, and while a lot of them can be found online, a good number of motherboards still come with physical items (just in case, you know, you can't get online with your machine). The good news is that you can check out the motherboard manual before you buy it to make sure you can follow what's going to

↘ submit your questions to: comments@maximumpc.com

be happening before you buy the motherboard itself.

Having recently been sorting problems out on a Gigabyte motherboard, you have our sympathies when it comes to some UEFI setup interfaces. Of the two you mention, we tend to favor Asus, but MSI has been improving recently, so there really isn't much in it. In fact, even Gigabyte's more recent motherboards have improved things significantly, so the situation isn't as bad as it once was.

## Storage Wars

I think Tuan needs to invest in his own cabinet or shelf at a data center. Oh, wait a minute—we are all averse to cloud storage, and not taking any chances of anyone snooping on our packets/frames/segments of data. Twelve 12TB hard drives for 144TB of storage space? Holy moly! Do you really have that much data that you will take advantage of all the space? I suspect you have already considered a RAID 10 setup as well.

How about offsite storage considerations? Have you thought about installing a backup generator for your home. Perhaps two? Make sure they are of different makes, of course—but I suspect Tuan has this covered. May I recommend sourcing two different diesel fuel suppliers, too, just in case the supply chain is impacted by a power grid failure due to the electrical needs at his home? Perhaps a SAN would be more in order from NetApp or Dell EMC, or something?

Ahahahaha! Sorry, I just had to get that out there, but I can totally relate. Thinking about getting a NAS myself, and I'll keep in mind the benchmark Tuan has set for his home storage needs.

**–James "Changr" Chang**

**EDITOR-IN-CHIEF TUAN NGUYEN RESPONDS:** Actually, the 12x 12TB drives were just for one NAS—I have five. It's pretty holy-moly, as you put it. For redundancy, they're all running RAID 6, and they have scheduled hourly, daily, and weekly backups—between each other and to Amazon Cloud. I have a pretty extensive firewall appliance from Netgate, running pfSense, and it's a 10gbit 1U firewall unit as well. All equipment is running off multiple APC Smart-UPS units, and I briefly considered a Tesla Powerwall 2 for the house. I decided against it in the end.

**[NOW ONLINE]**

## WHAT YOU NEED TO KNOW ABOUT MINING CRYPTOCURRENCY

Cryptocurrency news has been hot of late, thanks in no small part to the skyrocketing prices of Bitcoin and Ethereum, two of the largest cryptocurrencies right now. Litecoin and other cryptocurrencies are also up in value, and given the prices on graphics cards that are supposed to be useful for gaming, some of you will inevitably wonder: Should I get into the mining business?

That's a big, open-ended question, and the answer depends on many factors. We're not going to try to cover every aspect (because Google is your friend), but we'll quickly go over the basics of what you would need to get started, and include some rough estimates of how much money you might make when all is said and done....

Read the full article at http://bit.ly/2vDZnEn

## Workstation Standoff

You recently ran a comparison between AMD and Intel regarding workstation performances, centering on video rendering and Gigapan image editing. The microprocessors in question, the Ryzen 7 1800X and Intel Core i7-6950X, are comparable in relation to their multi-processing abilities, but that's about it. Have you run these same benchmarks using the Threadripper (16-core) and Skylake-X (18-core)?

As stated many times in your magazine, it is difficult to fairly benchmark systems be they alike, and we are talking about two computer systems here, not apples and oranges, even though one could say it is like comparing a family sedan to a sports car. The cost of an Intel machine vis-à-vis Skylake-X (18) to AMD Threadripper (16) is +$1,000 US just for the processor. I'm writing this from Canada, which puts it in an elevated market position, but doesn't unfairly test against AMD in the above scenario.

**–Murray McCullough**

**DEPUTY EDITOR ZAK STOREY RESPONDS:** You've got a very good point, and we're definitely planning on revisiting this concept some time soon. Our particular Intel versus AMD build-off in that issue actually tried to tackle two separate questions. First, which platform was stronger, and secondly, how the memory speed and capacity affect performance.

As for the future, the plan right now is to take two identically priced systems—specifically, identically priced parts (so a $160 Ryzen 5 1500X versus a $160 Intel Core i5-8400)—and pit them against each other, in a flat-out gaming and everyday benchmarking challenge. One Ryzen, one Intel, featuring identical storage and memory setups, too, to eliminate any potential anomalies.

## Off the Grid

We're now in the age of super graphics cards, and Nvidia has built an industry around its Grid for running VMs, so how about an article on how Amazon, Microsoft Azure, et al are using these systems?

But what I would really like to know is could I run multiple Windows/Linux VMs on my 1080 (or Titan V, if I upgrade)? As a gamer and a developer, I would love to have the best of both worlds: a hot machine and a mini data center for all my servers, and so on.

So, how about it: an article on how I would go about setting up my own data center using Nvidia Grid for home use?

**–Seán McPoland**

**EXECUTIVE EDITOR ALAN DEXTER RESPONDS:** A feature on how the big cloud operators work should be fairly straightforward. The second part may be tougher, though. But we like a challenge here on *Maximum PC*, and this looks like it will certainly be that. We're not sure how possible it would be to build your own data center, but we're happy to find out. Watch this space.

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# THE BUILDS

## BUDGET

### INGREDIENTS

| PART | | | PRICE |
|---|---|---|---|
| Case | Phanteks Enthoo Evolv ITX | | $70 |
| PSU | EVGA 450 BT Bronze | NEW | $45 |
| Mobo | ASRock AB350 Gaming-ITX/ac | | $115 |
| CPU | AMD Ryzen 3 1200 | | $110 |
| GPU | Asus GeForce GTX 1050 Ti 4GB Dual | NEW | $170 |
| RAM | 8GB (2x 4GB) ADATA XPG Gammix D10 2666 | NEW | $100 |
| SSD | 120GB HP M700 2.5-inch SSD | NEW | $50 |
| HDD | 1TB WD Blue 1TB 5,400rpm | NEW | $46 |
| OS | Ubuntu Desktop Linux 16.04 LTS 64-bit | | $16 |

**Approximate Price: $722**

**WHAT A MONTH!** Black Friday, combined with New Years sales, has really done a number on our budget build this time around. And we've got one other big issue right now, which is the result of two horrendous predicaments: GPU prices have skyrocketed. Our GTX 1050 Ti card from last month has catapulted in cost by a staggering $70. We've gone for an Asus variant to try to offset some of that burnthrough, but it still increases the price of our GPU of choice by a not so comfortable $12. The causes? Cryptomining still being a thing, and memory shortages now affecting VRAM as well. You simply can't win, huh? We've tried to save as much money as we can elsewhere, though. Storage has taken a dramatic hit—we've gone for a slower HDD, and a lower-spec SSD, too. Yet, amazingly, we've managed to save $5 on our new memory kit. Either way, though, this is not a comfortable situation to be in.

## MID-RANGE

### INGREDIENTS

| PART | | | PRICE |
|---|---|---|---|
| Case | NZXT S340 Elite | | $80 |
| PSU | 550W Corsair RM550X | NEW | $90 |
| Mobo | MSI Z370 Tomahawk | NEW | $130 |
| CPU | Intel Core i5-8400 | NEW | $200 |
| Cooler | Be Quiet! Dark Rock 3 | NEW | $75 |
| GPU | PNY GeForce GTX 1070 Ti 8GB | NEW | $500 |
| RAM | 16GB (2x 8GB) ADATA XPG Gammix D10 2666 | NEW | $178 |
| SSD | 256GB Samsung SM961 M.2 PCIe SSD | NEW | $146 |
| HDD | Western Digital Blue Series 1TB 7,200rpm | | $49 |
| OS | Windows 10 Home 64-bit OEM | | $100 |

**Approximate Price: $1,548**

**IN THE FIGHT AGAINST THE MEMORY AND GPU HIKES,** we've had to get a little extreme with our mid-range build. Last month's GPU increased in price by an astronomical $250, so that was out of the question. We went for the next best thing (meaning cheapest here): one of PNY's reference GTX 1070 Ti variants. However, that's still an additional $50 over what we saw last time, so to combat that we've decided to give the entire build a fresh lick of paint with a brand new spec to reduce the pain. This time around, we're going with our CPU of choice: Intel's Core i5-8400. It's $20 cheaper than the Ryzen equivalent, and we can drop the frequency on the memory kit, saving us an additional $40 in the process. On top of that, the liquid cooler has hit the bench in favor of a more affordable Be Quiet! Dark Rock 3. It's sexy, black, quiet, and has plenty of grunt to keep our tiny hex-core processor sufficiently chilled.

**WE ALWAYS ALLOCATE** a much larger word count to our turbo build than the others, but the reality is that it's usually the system that changes the least. The thing is, the value of the dollar, when building a system, varies. Simply put, the bigger the budget, how you allocate each buck holds far less weight than, say, at $700. A $40 difference with a $3,200 budget, for instance, is only around 1 percent of your spending limit, whilst back at that $720 mark, it's nearly six times that.

The biggest changes we've seen this month, across the board, stem from the ongoing memory price hikes. Whether it's GPUs or DDR4 DIMMs, you simply can't win right now. It's a very clear way of seeing how limiting the supply of one crucial component in an ecosystem can spill over and affect everything else. Hell, we're even hearing rumors that Samsung's next flagship phone will only sport 4GB of memory and use fewer chips, just to save on cost. Pure madness.

Our turbo build has stuck firm this time around, with only a couple of minor changes. We've gone for the absolute cheapest 32GB 3,200MT/s quad-channel memory kit we could get our hands on, to maintain performance across four sticks, and we've also dropped the additional fan off the Noctua CPU heatsink that we included last issue, to try to compensate for that $150 price increase for the Threadripper 1920X. Aside from that, little else has changed. AMD's Threadripper platform is still, by far, one of the best price-to-performance setups you'll find for rendering and workstation tasks, and well worth the cash if you're likely to profit from it.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

## INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | Phanteks Eclipse P400S Tempered Glass Silent Edition | $90 |
| PSU | Corsair RM750X Modular Gold | $110 |
| Mobo | Asus Prime X399-A | $350 |
| CPU | AMD Ryzen Threadripper 1920X | $800 |
| Cooler | Noctua NH-U14S TR4-SP3 140mm **NEW** | $80 |
| GPU | MSI GeForce GTX 1080 Ti ARMOR 11G OC | $750 |
| RAM | 32GB (4x 8GB) G.Skill Ripjaws V Series DDR4 3200 **NEW** | $406 |
| SSD | 512GB Samsung 960 Pro M.2 NVMe | $330 |
| HDD | 4TB WD Black 7,200rpm | $185 |
| OS | Windows 10 Home 64-bit OEM | $100 |
| **Approximate Price:** | | **$3,201** |

## UPGRADE OF THE MONTH

### INTEL CORE i5-8400

Whatever your stance on Intel's reaction to Ryzen, it's hard to argue against how impressive its new Core i5 series processors are. Our favorite, the Core i5-8400, packs a whopping six cores and six threads into the LGA1151 form factor, and boy oh boy, what a difference it makes! It's essentially the equivalent of getting an old-school Kaby Lake Core i7-7700K for almost $100 less. Two extra physical cores absolutely trump Hyper-Threading, and to be frank, this is simply something we can't get behind enough. It's not perfect, mind you—we really do wish that Intel would solder the IHS to the CPU die, instead of using that crappy thermal gunk instead. The Core i5-8400 is fortunate, because it's not too toasty, but the unlocked variants and their more powerful Hyper-Threaded compadres can get mighty warm, even under the best liquid coolers out there. **$200, www.intel.com**

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